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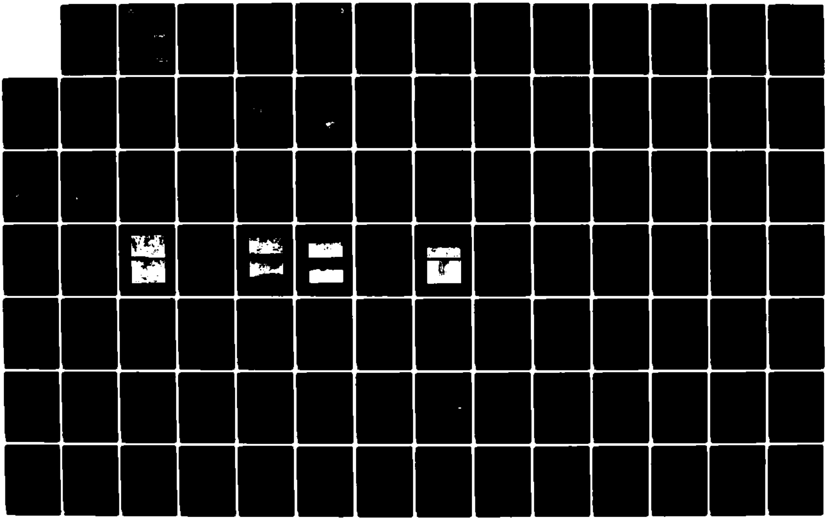

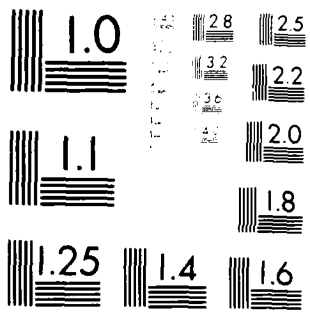
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US Army Corps
of Engineers
Fort Worth District

AQUILLA LAKE
BRAZOS RIVER BASIN,
TEXAS

PRE-IMPOUNDMENT ENVIRONMENTAL STUDY

SUPPLEMENT TO
DESIGN MEMORANDUM No.9
MASTER PLAN
(IN RESPONSE TO: 40 CFR 1505.3)

JUNE 1983

SECURITY CLASSIFICATION OF THIS PAGE (When Data Entered)

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20. ABSTRACT (Continue on reverse side if necessary and identify by block number)

Aquilla Lake is a reservoir project of the U.S. Army Corps of Engineers, Fort Worth District. This report was prepared to meet the requirements established and mandated by the "National Environmental Policy Act of 1969" and further the objectives of the Office Chief of Engineers stated policy of protecting environmental concerns in all phases of planning, design, construction, and operation and maintenance of each water resources project. This study provides a detailed description of the fish and wildlife resources and environmental quality of the Aquilla Lake project area. With this basic study the Fort Worth

Distirct will have a point of reference and be able to monitor project related changes and improve the understanding for all individuals with regard to the impact Corps of Engineers water resource projects have on the local fish and wildlife resources.

PRE-IMPOUNDMENT ENVIRONMENTAL STUDY OF AQUILLA LAKE

Prepared for

Fort Worth District
Corps of Engineers

by

R. Douglas Slack
Principal Investigator
Department of Wildlife and Fisheries Sciences
Texas A&M University

and

Larry E. Marcy
Research Assistant
Department of Wildlife and Fisheries Sciences
Texas A&M University

Project Staff:

Habitat Evaluation:	Nova J. Silvy Larry E. Marcy
Limnological Investigations:	W. J. Clark J. M. Campbell
Avian Community Analysis:	K. A. Arnold Tonna Harris-Haller
Mammalian Community Analysis:	W. E. Grant Cynthia Struzik
Fish Population Investigations:	R. L. Noble

June 1983

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INTRODUCTION

Aquilla Lake is one of 12 Corps of Engineers reservoirs in the Brazos River Basin that is existing, under construction, in preconstruction planning, or authorized. Congressional authority for the construction of Aquilla Dam and Lake, Aquilla Creek, Texas, a unit in the pla of improvement for the Brazos River Basin, is contained in the Flood Control Act of 1968, Public Law 90-483 (82 Stat. 741) 90th Congress, approved August 13, 1968. The authorized purposes of this project are flood control, water supply, recreation, and fish and wildlife conservation. The project is being developed for minimum recreation because of the absence of a local sponsor to cost-share recreational development. In accordance with Section 102 of NEPA of 1969, the final environmental statement for Aquilla was completed and filed on 13 April 1976 with the Council on Environmental Quality (CEQ).

The dam site is located on Aquilla Creek in Hill County at river mi 23.6 (38 km) approximately 6.9 mi (11.2 km) southwest of the city of Hillsboro (see map, Fig. 1). The Aquilla Creek watershed is in the middle portion of the Brazos River Basin in central Texas and has a maximum length of about 41 mi (66.4 km) and a maximum width of about 16 mi (25.9 km). Aquilla Creek originates near the city of Cleburne and flows a distance of about 54 mi (85.5 km) in a south to southeasterly direction to its confluence with the Brazos River. The area is characterized by generally rolling hills with narrow valleys and streams which are moderately entrenched. Total fee lands for the project are 10,213 ac (4,134.8 ha) of which 387 ac are required for project operations and 3,280 ac (1,327.9 ha) will be within the conservation pool. Because no recreation development is proposed initially, there will be 6,546 ac (2,650 ha) of flood pool and fee take lands available for fish and wildlife management purposes. Additionally, flowage easement has been acquired on 2,200 ac (890.7 ha).

PURPOSE OF STUDY

The environmental mission of the Corps of Engineers is to carry out the mandate of the "National Environmental Policy Act of 1969" to "...encourage productive and enjoyable harmony between man and his environment; to promote efforts which will prevent or eliminate damage to the environment and biosphere and stimulate the health and welfare of man; and to enrich the understanding of the ecological systems and natural resources important to the Nation." Implicit in the Chief of Engineers' policy to carry out the mandate are four general environmental objectives. These objectives are to preserve, to conserve, maintain, and enhance our natural resources and to create new opportunities for the use and enjoyment of our environment.

In an effort to further the objectives of the Chief's policy of protecting environmental concerns in all phases of planning, design, construction, and operation and maintenance, the Fort Worth District is conducting pre-impoundment and post-impoundment studies of the Aquilla Lake project. The purpose of these studies is to provide an additional detailed baseline description of the fish and wildlife resources and environmental quality of the project area prior to construction from which the District may monitor project related changes until reasonable stabilization of impacts is reached. The study objective is to improve our understanding of the impact of

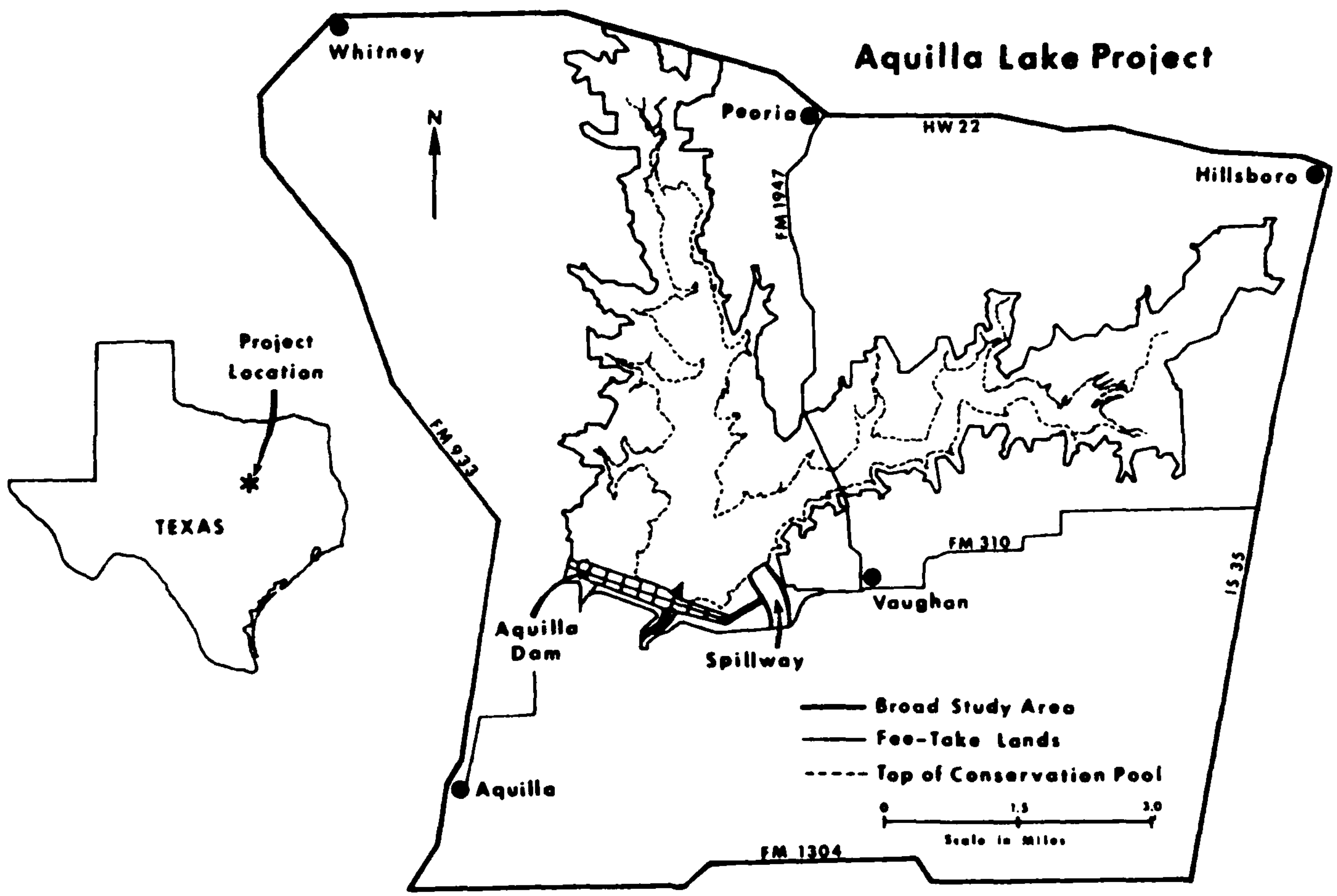


Figure 1. Location of Aquilla Lake Project in Hill County, Texas.

Corps water resource projects, to provide the basis for evaluating the project's effects on fish and wildlife resources, and to provide the opportunity for better planning and development of water resource projects and natural resource management. This report presents the results of the pre-impoundment investigations.

STUDY AREA

Hill County is located within the Blackland Prairie (BP) and Eastern Cross Timbers (ECT) Land Resource Areas in north-central Texas (Fig. 2). The BP is typified by alkaline black clay soils with high organic content overlying the parent Cretaceous limestone. Prior to extensive cultivation, the dominant herbaceous vegetation was little bluestem (*Schizachyrium scoparium*). Due to agricultural practices, this species has been reduced to small scattered areas in eastern Hill County.

The ECT is a belt of post oak (*Quercus stellata*) and blackjack oak (*Quercus marilandica*) woodland closely following the aquiferous Woodbine sand formation from the Red River into southern Hill County, with a few scattered remnants in McClennan County. Prior to extensive agricultural and grazing practices, the dominant herbaceous species was little bluestem. Grazing, farming, and fire suppression have allowed encroachment of invader species, reducing natural stands of little bluestem and associated oaks to only a few sites within the ECT.

Hill County is nearly level to rolling, and well dissected by natural drainage ways. Aquilla and Hackberry watersheds, located in the middle portion of the Brazos River Basin, are characterized by generally rolling hills with narrow valleys and streams which are moderately entrenched. Major drainages are Aquilla, Little Aquilla, and Hackberry Creeks.

Aquilla Creek (see map, Fig. 3) is a tributary of the Brazos River entering the Brazos at approximately river mi 421 (km 680), north of Waco. Aquilla is a 6th order stream by the Strahler method, and a number 448 stream by the Shreve method. The total watershed is 308 mi^2 (426.9 km^2). At creek mi 23.6 (km 38) the creek divides into two main tributaries; Aquilla Creek with an area of 126 mi^2 (174 km^2) and Hackberry Creek with an area of 133 mi^2 (184.4 km^2). Aquilla Creek above this confluence is almost entirely within the Eastern Cross Timbers province, with deep sandy loam (mildly alkaline to slightly acid) soils. Hackberry Creek watershed and the remainder of the watershed below the confluence is in the Blackland Prairie province with deep prairie clayey (moderately alkaline) soils. In 1972, about 46% of the county was used for general field crops, 43% was pasture, 3% woodland and 8% housing (Table 1). Wooded areas remain adjacent to waterways or in small woodlots in the central and western portions of the county.

The Aquilla Creek Lake Project (Fig. 4) is located mainly within the southern extremity of the ECT, and extends into the BP. The project study area is defined as all project lands purchased in fee and/or easement and all lands within the flood pool elevation of 556 ft (169.5 m) msl as well as the downstream flood plain. The dam site is located on Aquilla Creek in Hill County at river mile 23.6 (km 38) approximately 6.9 mi (11.2 km) southwest of Hillsboro, Texas. The conservation pool area is estimated at 3,280 ac (1,327.9 ha) and maximum water surface is 6,546 ac (2,650 ha). The eastern limits of the project (58.4%) extend into the BP with 41.6% of the project lands found in the ECT. In order to determine project related changes which

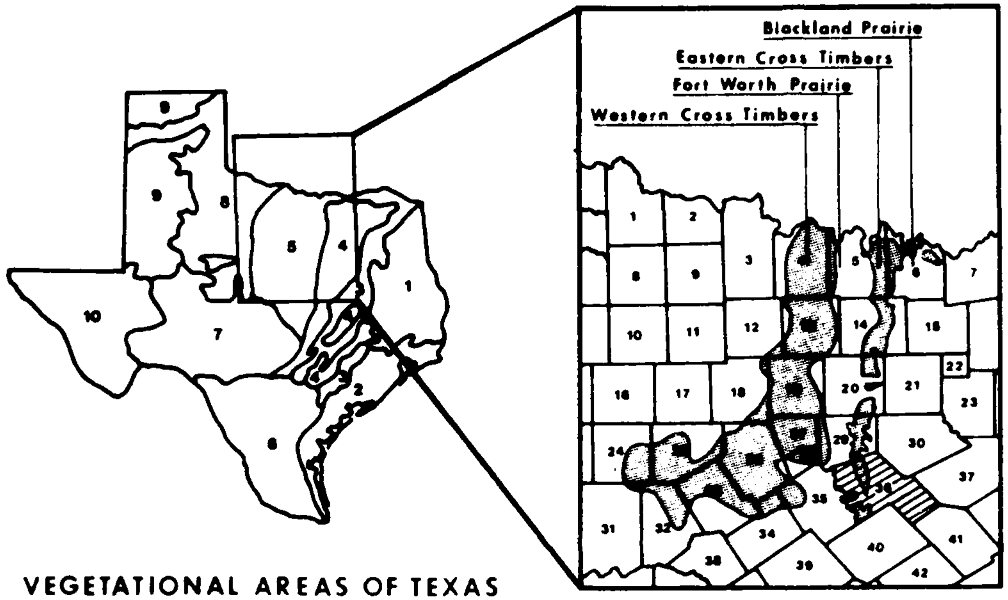


Figure 2. Location of Hill County within the Blackland Prairie, Fort Worth Prairie, and Eastern Cross Timbers of north-central Texas.

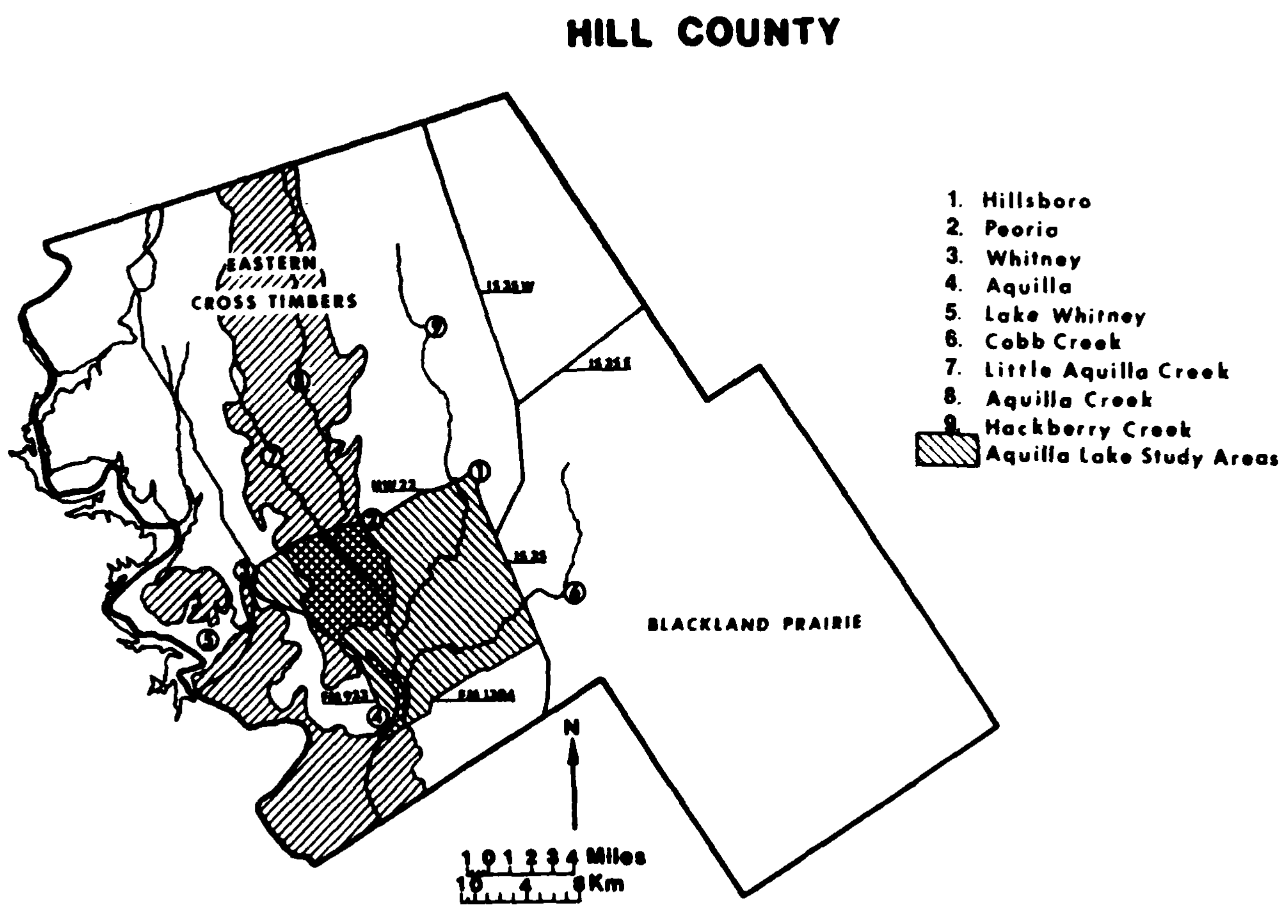


Figure [illegible]. Location of the Aquilla Lake Project within the Blackland Prairie and Eastern Cross Timbers of Texas.

Table 1. Comparison of Hill County land use with project land use 1972.

Land Use	% Hill Co.*	% Broad Study Area	% Project Area
Cropland	46%	51.9	46.8
Pasture	43%	25.5	14.2
Forest	3%	20.6	39.8
Housing	8%	1.9	--**

* Data from Soil Survey of Hill County, 1975.

** No housing land use was determined since all houses have been removed from project area.

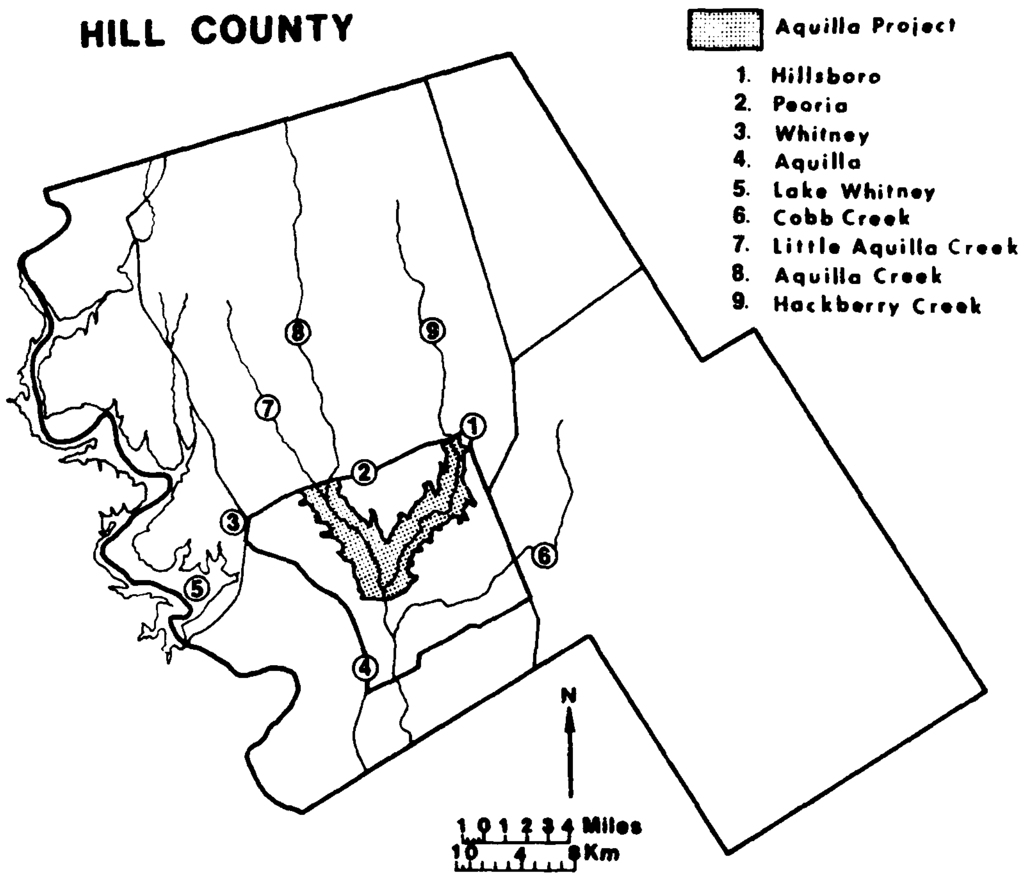


Figure 4. Location of the Aquilla Lake Project area within Hill County.

are indirect results of the project, a broader study area has been defined as that area bounded on the north by State Highway 22, on the west by County Road 933, on the south by County Road 1304, and on the east by Interstate 35. The broad study area excludes all areas within the limits of incorporated cities or towns and is composed of 74.6% BP and 25.4% ECT.

Land use changes, and habitat type quantification were studied on the project study area and the broad study area. Intensive studies of vegetation, terrestrial wildlife, and aquatic resources were completed on the project study area and at a location immediately south of the dam site.

The limate of Hill County is representative of north central Texas. Hill County is hot in summer but cool in winter, when an occasional "Norther" causes a sharp drop in temperature. Average winter temperature is 47°F (8.3°C). In summer, the average temperature is 83°F (28.3°C). Extremes in temperature occur; in winter reaching 2°F (-16.6°C), and summer reaching 111°F (43.9°C).

Of the total annual precipitation of 34.6 in (88 cm), 19 in (48.2 cm) (55%) usually falls in April through September. In 2 years out of 10, rainfall in April through September is less than 14 in (35 cm). In 70% of winters, there is no measurable snowfall. In 25% of winters, snowfall accumulation is more than 2 in (5 cm).

The average relative humidity in midafternoon is about 60%. Humidity is higher at night and the average at dawn is about 85%. Southerly prevailing winds average 13.5 mph (21.8 kmph). Highest winds occur in March and April. During these months skys often are partially obscurred by blowing dust from agricultural areas.

The year previous to the study, and including the spring of 1980, was wet and mild, with an average precipitation of 5.4 in (13.7 cm) above normal (Fig. 5). The summer of 1980 through 1981 had a 7.2 in (18.3 cm) decrease in precipitation, and a 5°F (2.8°C) increase in temperature. A summary of temperature and precipitation data for the study period is presented in Appendix A.

METHODOLOGIES

Vegetative and terrestrial wildlife studies required the establishment of 4 permanent transects through broad community types (Fig. 6). Transect locations were chosen through collaboration between the Fort Worth District and the contractor. Transect compass azimuths were determined from area maps. Transects were laid out on the ground by walking azimuths and were marked by flagging vegetation with orange surveyor's tape.

Qualitative habitat descriptions were based on data collected from 13 sampling plots of 107,593.2 ft^2 (10,000 m^2) each. Plots were established with the aid of compass, map, and 98 ft (30 m) tape measure at locations agreed upon between the Fort Worth District and the contractor. Corners of each plot were marked with wooden stakes 24 in (61 cm) in length and flagged with yellow and orange surveyor's tape. Stakes were numbered with the appropriate sampling plot designation according to transect number and location along the transect. For example, T 1-1 corresponds to transect 1, sampling plot 1. Sampling plots were numbered numerically from west to east along each transect.

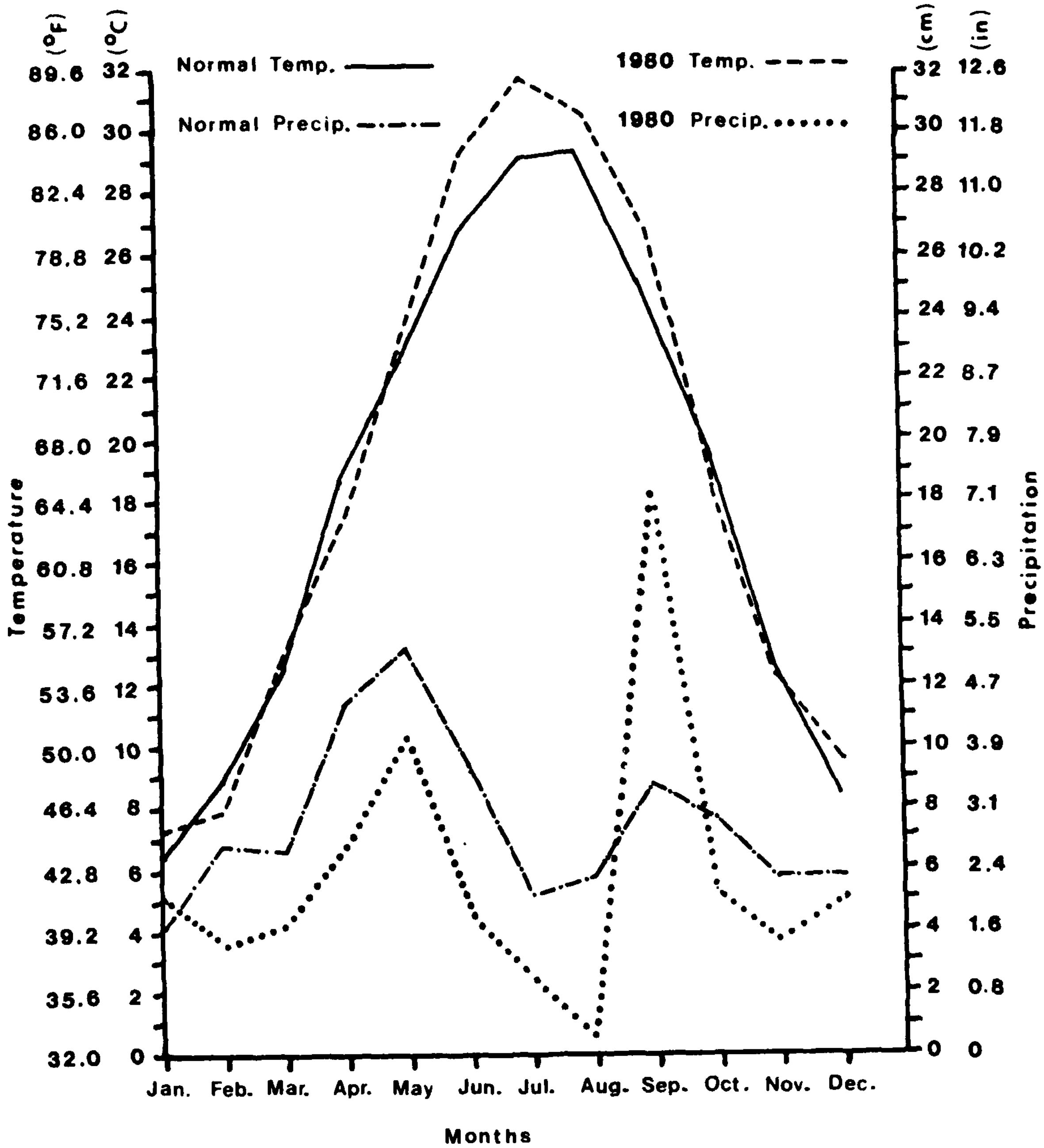


Figure 5. Comparison of temperature and precipitation data to the norm for Hill County.

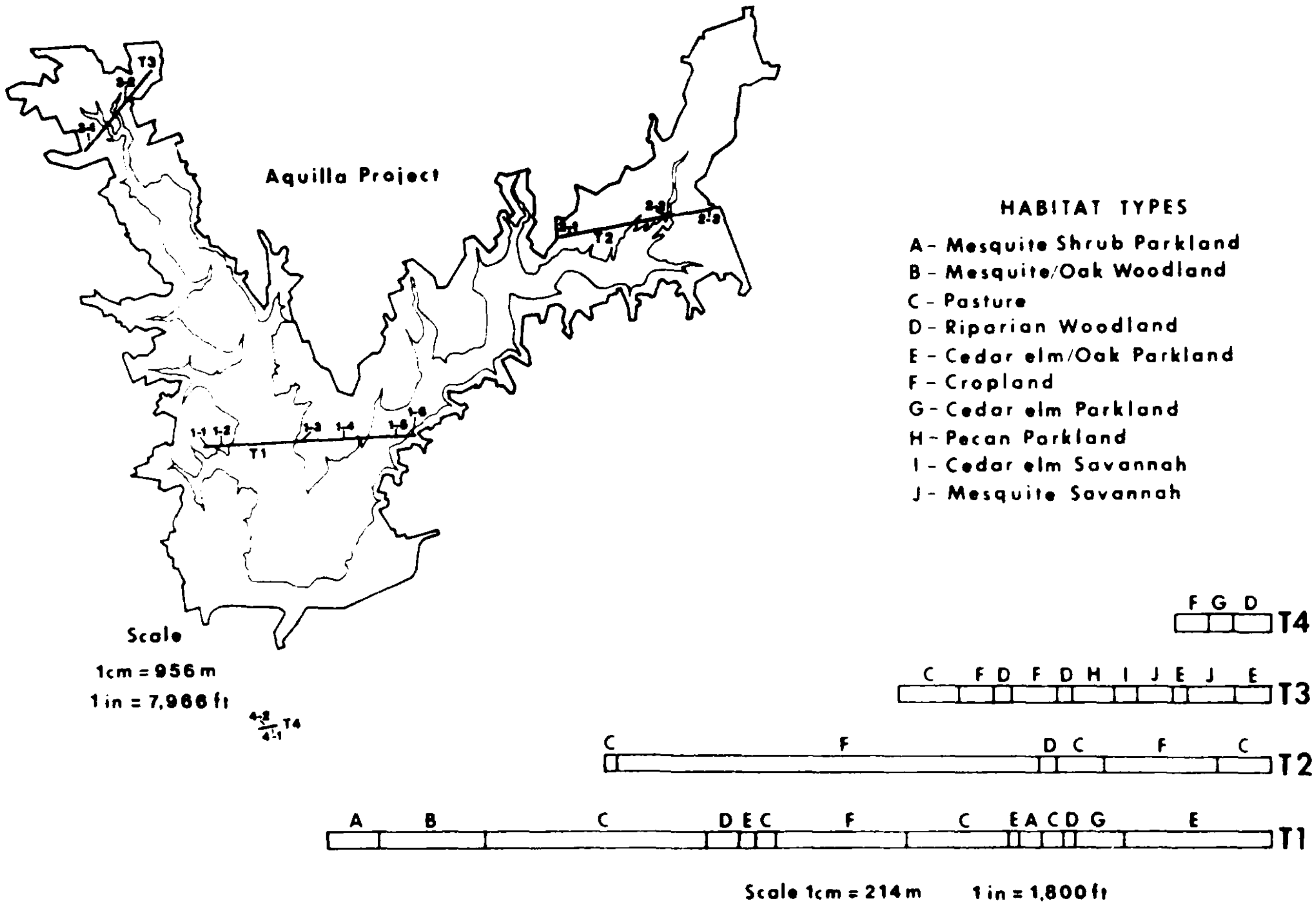


Figure 6. Locations of transects within the project area and habitat types along each transect.

Habitat Types

A habitat type classification scheme was developed from Grue et al. (1976), and incorporated a similar format as that used by the U.S. Fish and Wildlife Service (Fig. 7). A summary and explanation of this scheme is given in Appendix B. Habitat type quantification of the study area as it existed in May 1972 was determined by delineation of habitat types on black and white aerial photographs and by comparison with existing conditions during the study. The conservation pool boundary and the outer fee lands boundary were plotted on each aerial photo with the aid of maps furnished by the Corps and ground truthing of survey markers. A polar planimeter was used to determine the area of each habitat type. Color infrared photographs taken October 1979 and October 1982 were prepared for analysis by (1) cutting each photograph from film strips, (2) applying overlays, and (3) delineating mutually exclusive boundaries on each photo. Habitat types were assigned, where applicable, using height of ground cover, canopy composition, and growth form of the vegetation.

Ground truthing of the 1979 aerial photos was carried out using a scheme developed by Hay (1979). Each category determined from delineations was sampled separately and combined in an overall sample. Samples were randomly selected over the broad study area, the stratum into which each fell was identified and a running total for each stratum maintained. Once any one of the strata had a sufficient sample size (100), the overall sample was complete. Sampling continued until 100 samples of each additional strata were collected. Within the overall sample, 15 strata were identified and checked for accuracy with the photo delineations. Overall sample size was 310, while 1,500 subsamples were taken to complete ground truthing.

Vegetation

In most plant communities, the taxa attain their maximal seasonal development at different times, hence a series of plots must be studied at different seasons to permit evaluation of each taxon near the time when it is exerting maximal influence upon the remainder of the ecosystem (Daubenmire 1959). Vegetation sampling was timed to correspond to this maximal influence according to the following schedule:

Spring Sample - May-June 1980

Summer Sample - July-August 1980

Fall Sample - November-December 1980

Winter Sample - January-February 1981

Spring Sample - March-April 1981

Prior field observations of the Aquilla Lake area showed that the vegetation complex consisted of 4 layers: overstory, understory, shrub, and herbaceous. Vertical stratification was based upon the following definitions:

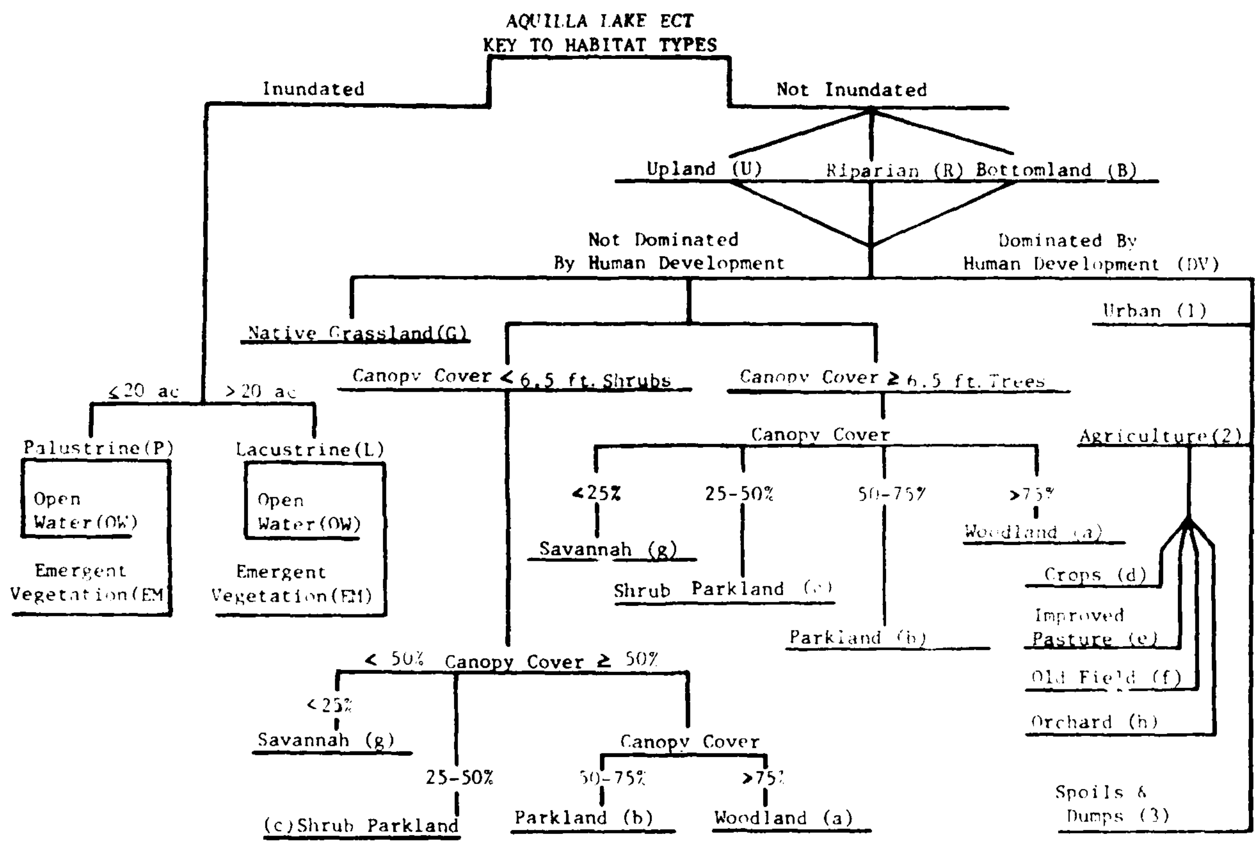


Figure 7. Aquilla Lake habitat type classification scheme.

Overstory - the layer of trees in a forest that forms the canopy and exerts major influence on the rest of the forest.

Understory - collectively, the tall perennial shrubs and trees >6.5 ft (2 m) in height, but below the upper canopy.

Shrub - a perennial woody plant of low growth < 6.5 ft (2 m) in height and with 1 or several stems arising from the base.

Herbaceous - a non-woody plant with one or more stems that die back to the ground each year. Grasses and forbs, annuals or perennials (Hanson 1962).

The vegetation complexity required 2 sampling methods — canopy coverage and point-quarter. Daubenmire's (1959) canopy coverage method was used to sample herbaceous vegetation. Canopy coverage is one of the most important parameters of a species in its community relations (Lindsey 1956). This method involves an evaluation of each taxon as to its percent coverage in relation to quarters of the plot, i.e., whether the coverage is between 0-5, 5-25, 25-50, 50-75, 75-95, or 95-100%. A plot frame 7.8 x 19.7 in (20 x 50 cm) (inside dimensions) was placed at randomly selected points, and the taxa included therein and their coverage values were recorded. Plants not rooted within the plot were also measured if parts of the plant or a vertical projection of the plant on to the ground influenced the plants within the plot. In addition, the number of individuals within the plot were recorded to give an estimate of density.

The point-quarter method (Avery 1967) was used to sample overstory, understory, and shrubs. Basal area was determined for overstory and understory species at 4.3 ft (1.3 m) above the ground (breast height). Shrub basal area was measured at 1 in (2.5 cm) above the ground. The area around each preselected sampling point was divided into 4 equal quadrants. The individual plant nearest the point in each quadrant was located and its basal area and point-to-plant distance determined. Point-to-plant distances were measured to the center of the rooted base.

Sampling adequacy of herbaceous vegetation was determined from T 3-1 which, from a previous reconnaissance, proved to have the highest herbaceous density. A comparison of percent canopy coverage against plots sampled showed that 20 samples would be an adequate representation of a plot (Fig. 8). However, 40 samples per plot were taken throughout the study to give a more than adequate sampling of the herbaceous vegetation. Daubenmire (1959) has shown that 40 sampling plots 7.8 x 19.7 in (20 x 50 cm) were adequate to sample the most complex vegetation. A species coverage per area curve was used to determine sampling adequacy of the woody vegetation (Fig. 9). Forty samples of overstory, understory, and shrubs were taken. These vegetation levels do not change over the season. Therefore, 40 samples per area were adequate.

Random sampling was achieved by dividing each of the 13 plots into 100 subunits of 1,076 ft^2 (100 m^2) each. Within a sampling area, 10 subplots were randomly chosen from 100 numbered discs. Each subplot was divided into 100 possible sampling points and 4 sampling points within each 107.6 ft^2 (10 m) subplot were chosen in the manner above to give a total of 40 sampling points

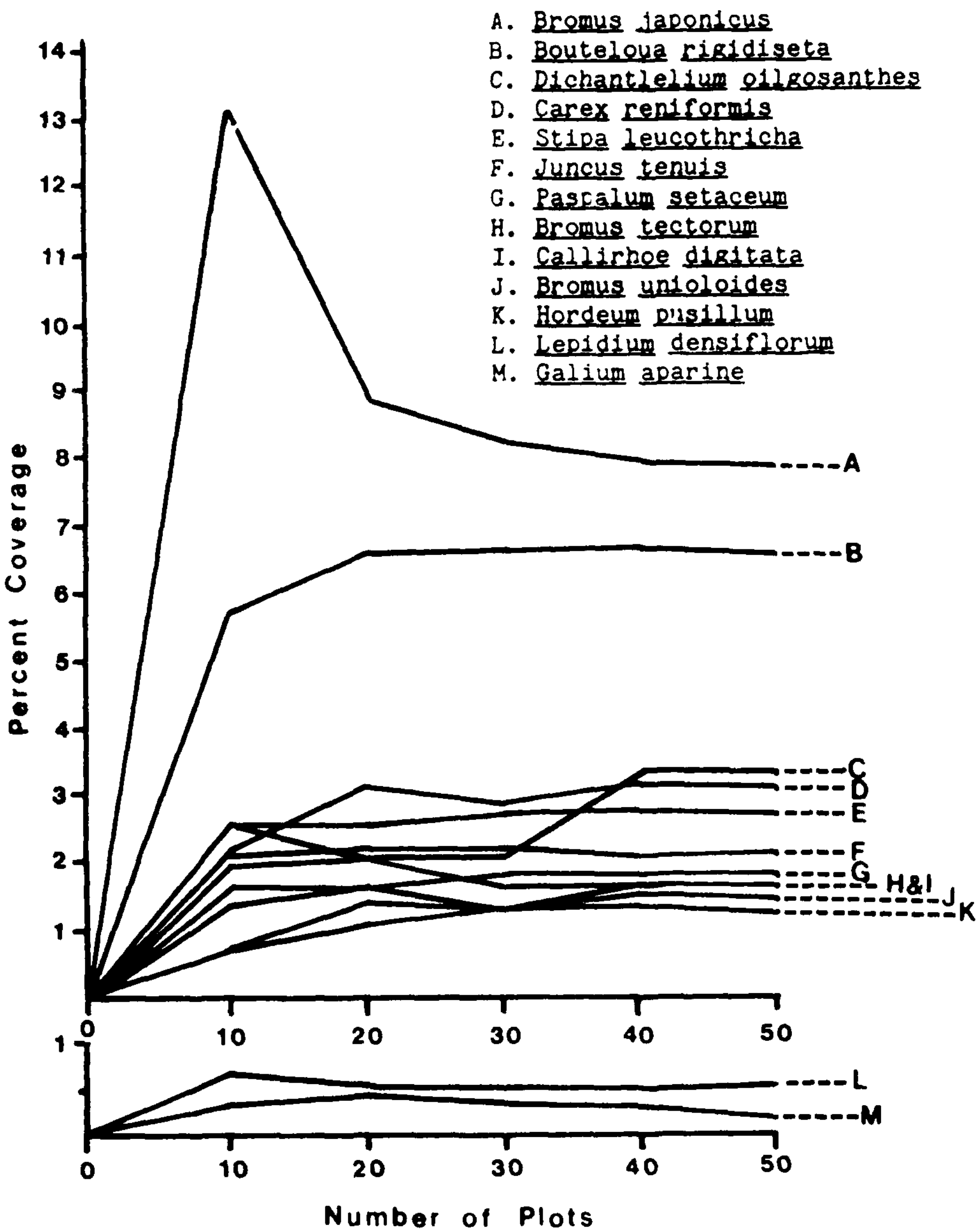


Figure 8. Species area curve used to determine the sample size for herbaceous vegetation.

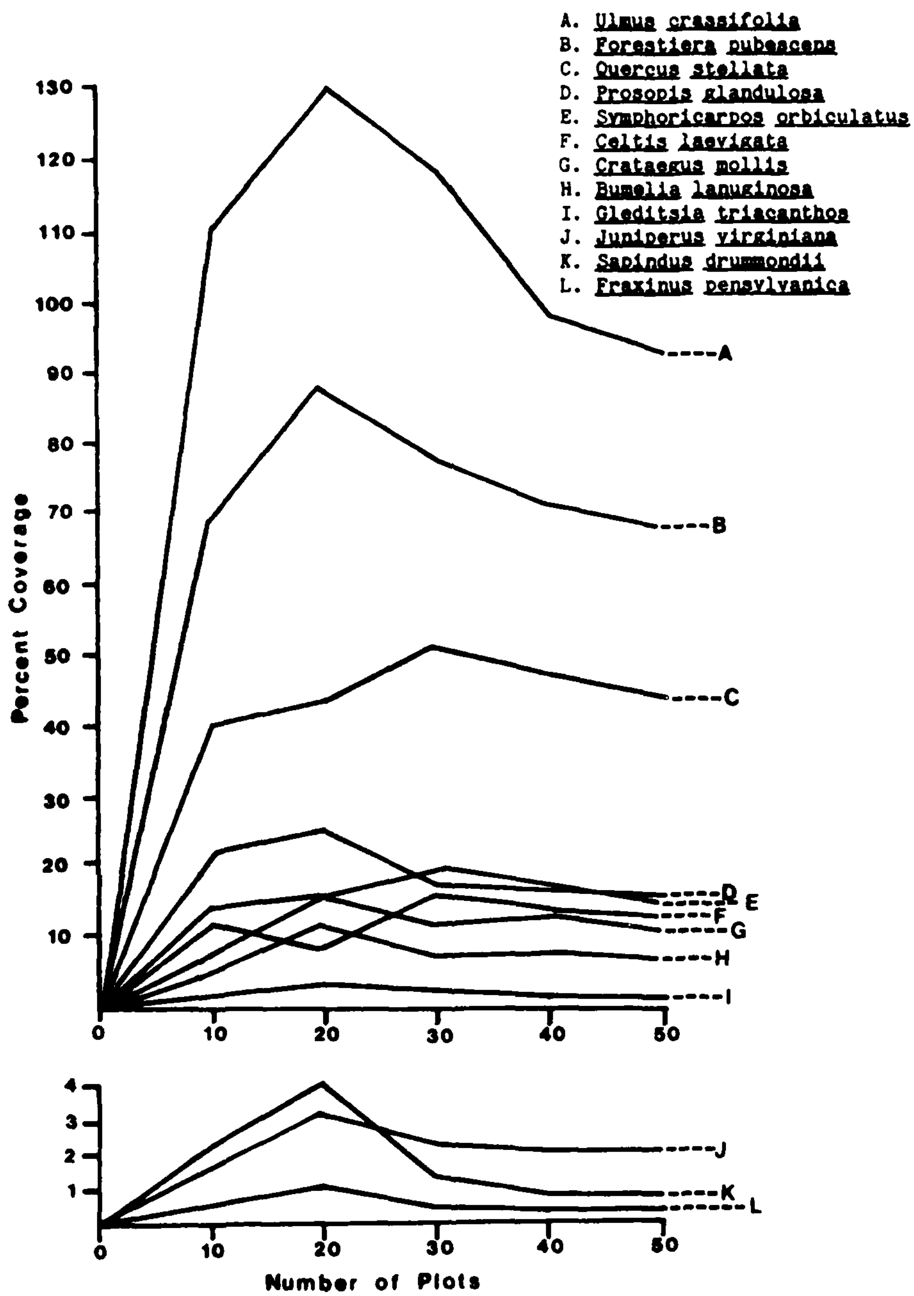


Figure 9. Species area curve used to determine sample size for woody vegetation.

per area per season. Overstory, understory, and shrubs were sampled from 1 of the 4 sampling points for a total of 10 sampling points per area per season.

All species' common and scientific names were based on Correll and Johnson (1970). Unidentified species were given letter and number designations according to the following scheme until identification could be accomplished:

UIT - Unidentified tree

UIS - Unidentified shrub

UIF - Unidentified forb

UIG - Unidentified grass

Example: UIG 2301 = Unidentified grass number 01, found on transect 2, grid 3. All species identified during the study were processed according to the procedure described by Porter (1967), and were deposited in the herbarium of the Department of Biology, Texas A&M University.

The following 4 parameters, where applicable, were evaluated for each species:

Relative density - a comparison of the density of one species to the density of all species.

Relative dominance - the ratio of the basal area or coverage of one species to the total basal area.

Relative frequency - a comparison of the frequency of one species to the total frequencies of all species.

Importance value - an index to the worth of a species as a component of an ecosystem determined by the summation of relative values of density, dominance, and frequency.

Total densities of each vegetative category were compiled. These data and the data compiled from the parameters defined above show the similarities and dissimilarities among the various areas, and provide a base from which long term effects of lake construction on the vegetation can be determined.

Between the fall and winter sampling periods each transect and grid was surveyed for new flowering species. Following the winter sample, bi-weekly surveys and collections of flowering plants were made to help identify unknown species which had been collected and cataloged during the winter sample.

Terrestrial Wildlife Resources

Avian community data were taken from March 1980 through February 1981. Diurnal raptors, owls, gamebirds, and songbirds were censused. Diurnal raptors were primarily censused with time-area counts centered on the study plots. Eight time area count areas were conducted several times per month for diurnal raptors. Count areas covered all sample grids in both BP and ECT habitats. Additional incidental sightings were recorded, and raptor data were

collected along songbird transects. These data resulted in an index of abundance by major habitat type for diurnally active raptors. The major habitat types evaluated were: forest parkland, riparian woodland, and pasture and cropland. Overall diversity was calculated using the species richness equation, d = S/log N, where d = diversity, N = total number of individuals observed and S = number of species observed. Songbird census data were collected by methods described by Emlen (1971, 1977). All habitat types crossed by transects were recorded separately.

Two 19.8 mi (32 km) mourning dove and bobwhite call count routes were established on secondary roads, 1 each in the BP and ECT broad study areas. These routes were sampled using U.S. Fish and Wildlife Service procedures (Dolton 1976). In this study these routes were used to census calling mourning doves and bobwhite simultaneously. Each route was censused 4 times from mid-May to mid-June 1980.

A prerecorded tape of owl calls was used to elicit oral responses by owls. Data were gathered on the 13 sample grids. All data were collected between sunset and midnight and an index of abundance was determined. The standard used for owl indices was the number of responses obtained per hour of sample time by habitat type.

Songbird data were primarily obtained using the transect method devised by Emlen (1971). Additionally, 6 small spot-map grids were set up and censused during April and May, 1980. Each grid measured 328 x 656 ft (100 x 200 m). No birds were recorded on the grids that were not also observed on the transects. The ECT and BP habitat types were combined into 6 major habitat types found throughout the study area. These habitats were: forest parkland, riparian woodland, cropland, pasture, shrub parkland, and old field. Key species for each habitat type were determined as the most commonly occurring species during the field year. Densities were calculated using Emlen's (1971) coefficient of detectability. Wherever possible, permanent resident species were used in the key species analysis. However, in some habitats, seasonal migrants were so predominant that these species could not be ignored. Therefore some density values were affected by seasonal fluctuations in certain populations. This was especially true for some sparrows and blackbirds.

Besides songbirds, raptors and game birds were included as key species for each habitat. Key species thus comprise the majority of observations in any given habitat. Density calculations were rounded to the nearest whole number.

The hawk and owl species analyzed were combined into 'hawk' and 'owl' categories to facilitate analysis. In both cases, multiple species were included in the categories. Vultures, hawks, owls, bobwhite, mourning dove, common crow, and cardinal were evaluated for all habitat types. Bird names follow the American Ornithologists' Union (AOU) checklist (1975).

Data on the mammalian fauna of the Aquilla Lake project site were gathered over a 5 quarter period from January 1980 thru March 1981. Seasonal sampling of small mammals adhered to the following schedule: Quarter 1, January 1980 - March 1980; Quarter 2, April 1980 - June 1980; Quarter 3, July 1980 - September 1980; Quarter 4, October 1980 - December 1980; Quarter 5, January 1981 - March 1981. For data analysis purposes, Quarters 1 and 5 were combined and referred to as Quarter 1.

Primary emphasis was placed on identification and determination of small mammal communities. Rodent trapping was accomplished with Sherman live traps, museum specials, Victor rat traps and box-type live traps. Sampling in Quarter 1 focused on evaluating trap success and the development of a

reference series of mammals for identifiction purposes. Rodent sampling effort in Quarters 2-5 consisted of 100-160 trap nights per quarter per accessible grid. Grids were those identified as sample plots for intensive vegetation community studies. Traps were set such that each of 50 stations had 1 Sherman live trap (baited with oat grain) and 1 snap trap (baited with oatmeal) per station. Box-type live traps and 6-26 mi (9.7-42.1 km) drive routes were used in Quarter 2 to assess the relative abundance of large mammals. Drive routes began at T2-3, then along FM 310 below the dam, across to FM 933, then to T1-1, 1-2, 3-1, and 3-2. From there the route continued to FM 1947 and terminated at T2-1.

Amphibians and reptiles were caught, identified, and released as seen throughout the project study area. A species list was compiled.

Recreational use of the project study area was monitored in conjunction with plant and animal sampling procedures. Type of activity, habitat type used, and date of occurrence were noted.

Aquatic Resources

Data for limnological investigations were taken quarterly at 5 stations: (Fig. 10).

Station A. First road bridge on Hackberry Creek above the confluence of Hackberry and Aquilla Creeks. Samples at 1st riffle and pool on downstream side.

Station B. At abandoned bridge at 1st road access on Aquilla Creek above the confluence of Hackberry and Aquilla creeks. Collections taken on upstream side of bridge.

Station C. Bridge of FM 1304 across Aquilla Creek, just southeast of Aquilla. Collections taken at 1st pool and riffle on the upsteam side of the bridge.

Station D. Bridge across Cobb Creek 1 1/2 mi (2.4 km) south of Vaughn. Collections made on downstream side of bridge.

Station E. Pool at upper end and riffle at lower end of Aquilla Creek at termination of terrestrial transect 4 south of dam site.

Extreme situations are powerful moderators of ecosystems, and one of the significant extremes for a small watershed in this climate is the summer period of minimum precipitation. Low discharge and high temperature during this period apply very high stresses.

The summer of 1980 was one of the hottest and driest on record, and thus creek water levels were at a minimum. Figure 10 shows all the watercourses, but the small upper tributaries contain water only during rains. Between rains, even in the rainy season, many of the watercourses are dry. The longer the interval between rains the more the channel length is without flowing water, unless there is a water source available such as the Hillsboro sewage

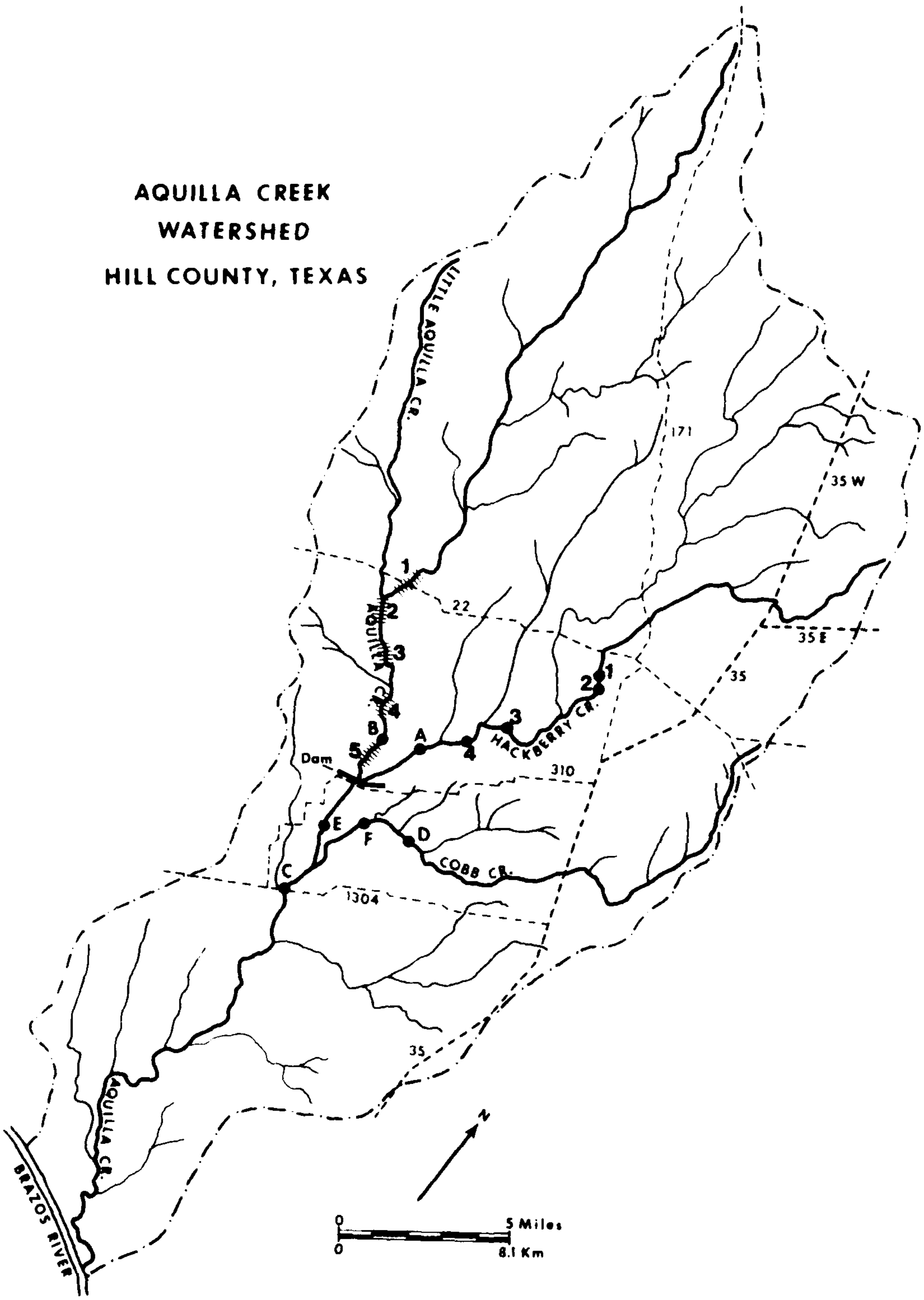


Figure 10. Map of Aquilla watershed showing location of limnological sampling stations.

outfall into Hackberry Creek. If aquatic organisms are to survive these dry periods there must be either an assured base flow as in Hackberry Creek, or for streams with no assured base flow, such as Aquilla Creek, the organisms must have resting stages or places of refuge. This pre-impoundment survey was intended to evaluate the summer low water status of these two tributaries.

Specific conductance, oxygen, and pH were measured in the field at the four regular Hackberry Creek stations. The other chemical parameters were analyzed in the laboratory. Analyses of physical and chemical parameters were accomplished using methods outlined in American Public Health Association (1975).

Effort was concentrated on stations A and B, since tributary evaluation was a prime objective. Station D on Cobb Creek was included as a more valuable comparative station than the 2 downstream stations.

Five areas of Aquilla Creek were chosen for physical/chemical analyses, from the dam site to just above the flood pool limit. Sections of the creek bed both up- and down-stream from the access point were "walked-out" and the number and approximate sizes of pools were recorded.

Pools were categorized either as long pools over 98 ft (30 m) long, medium-sized pools 16.4-98 ft (5-30 m long), or small pools less than 16.4 ft (5 m) long. Data on the lengths of stream sections walked-out and the lengths of pools found are summarized in Appendix C.

Along Hackberry Creek flowing water was observed at all access points from the sewage treatment plant at Hillsboro to the construction site of the dam. Qualitative samples of benthos and zooplankton were collected at each station (Fig. 10).

Quantitative quarterly benthic samples in pools were taken with a 39.7 in^2 (256 cm^2) Ponar. Three samples were taken in each pool, washed in a #30 mesh screen bucket, and preserved and stained with Formalin-Rose Bengal. Quantitative quarterly samples in riffles were taken with a 144 in^2 (929 cm^2) Surber. Three replicate samples were taken in each riffle, washed in a #30 mesh screen bucket, and preserved and stained with Formalin-Rose Bengal. Qualitative benthos samples for the low water survey were taken by scooping and washing bottom material with the #30 mesh screen bucket, and preserving and staining with Formalin-Rose Bengal. Two scoop samples were taken at each site. Samples were processed in the laboratory by pouring them into white pans and picking out organisms. Heads were removed from chironomid larvae, and the heads and bodies mounted in Euparal on glass slides.

Two tows for zooplankton of approximately 9.8 ft (3 m) length were taken in each pool with a #20 mesh net, and the samples preserved with Formalin. Samples were counted in a Sedgewick-Rafter cell and percent compositions calculated. Cladocerans have been verified by Dr. David Frey, Indiana University. Chironomids were identified using the key by William M. Beck, Jr. (1976). Other organisms were identified using Pennak (1978) and Usinger (1956).

Fish population samples were taken from 6 stations -- 1 each on Aquilla and Hackberry Creeks above their confluence (sites B and A, respectively), 2 on Aquilla Creek below the dam site (sites E and C), and 2 on Cobb Creek (sites D and F). These sites correspond to limnological study sites A-E; the 6th site (F) is on the lower reaches of Cobb Creek (Fig. 10).

Fish samples were collected utilizing both seining and electrofishing where possible; site B (upper Aquilla) was sampled using only electrofishing and site F using only seining. Seine samples consisted of 2 to 4 hauls with a 20-ft (6.9 m) seine having 1/4-in (0.63 cm) square mesh. Electrofishing was conducted with a variable voltage DC shocker using a hand-held anode. This

unit was operated from a small boat. Each electrofishing sample consisted of both an upstream and downstream traversing of the selected stretch of stream, during which collection of all stunned fish was attempted. In both the seine and electrofishing sampling, a variety of habitats was sampled to the extent compatible with gear type.

Except for several large specimens which were processed in the field, all fish were preserved and returned to the laboratory where lengths and weights were measured. Scales were taken from selected individuals for aging of fish.

RESULTS

Land Use Changes

Areas determined by mapping the Aquilla Lake Project facilitated the identification of major land usage in 1972. Land usage was primarily agriculturally oriented with 46.8% (4,848.1 ac = 1,962.8 ha) in cultivation, and 14.2% (1,467.9 ac = 594.3 ha) in pastures. Wooded areas and shrub/scrub lands accounted for 39.8% (4,047.1 ac = 1,638.5 ha) of the project area (Table 2). Areas used for housing within the project area were not determined as these structures were removed, resulting in a 100% difference between the 1972 and 1982 data.

In 1972, cultivated cropland comprised 51.9% (22,433.8 ac = 9,082.5 ha), pasture 25.5% (11,022.4 ac = 4,462.5 ha), woodland 20.6% (8,904.4 ac = 3,605.0 ha), and housing 1.9% (821.3 ac = 332.5 ha) (Table 3) of the broad study area.

Table 3 provides results of the 1979 land usage for the project, and broad study areas. Comparing the 1979 data to that of 1972 shows a decrease in all land uses from the 1972 figures, except urban. Differences in the pasture values could be attributable to the difficulty in distinguishing certain pasture lands from shrubland (shrubland being included in the major category of woodland) on black and white photos. Land under water (small farm ponds) accounted for the remaining difference. Within the broad study area, land lost to the construction of 453 ponds (from 1.0 to 2.5 ac = 0.4-1.0 ha in size) amounted to 618 ac (250.2 ha). Land used for ponds within the project area amounted to 203.2 ac (82.3 ha). Urban land use (home sites) of the broad study area increased by 13.7% from the 1972.

In the period 1972-1979, cropland decreased by 49.5% (2,401.2 ac = 972.1 ha) within the project study area. Succession resulted in a 47.1% (691.7 ac = 279.8 ha) increase in pasture. The amount of forest decreased 3.9% (156.7 ac = 63.4 ha). Aquilla dam construction resulted in modification of 243.1 ac (98.4 ha).

Detailed habitat type identification and quantification in 1979 was done for both the broad and project study areas (Tables 4 and 5). This detailed scheme allowed lumping the initial 102 habitat types into 18 types, from which maps 1 and 2 were derived (see map pockets inside back cover). Analysis of the habitat data by aerial photo interpretation sites for 1979 revealed that 8 major habitat types comprised 99.2% of the project area. Pasture and cropland habitat types accounted for the greatest percentages, 23.9% (2,446.9 ac = 990.6 ha), and 21.1% (2,159.0 ac = 874.1 ha) respectively (Table 6). Habitat types accounting for <1% were not sampled. Data collected from ground truthing 1979 aerial photographs suggests an overall accuracy of 293 correct delineations out of a sample size of 310 (or 94.2%), with a range

Table 2. Habitat type quantification of the project area as it existed in May 1972.

Habitat Type	Hectares	Acres	% Composition
Forest	1,113.4	2,750.2	26.5
Woodland	459.8	1,135.7	10.9
Parkland	541.6	1,337.4	12.9
Savannah	112,2	277.1	2.7
Shrub/scrub	255.5	631.0	6.9
Shrub Parkland	42.0	103.7	1.0
Savannah	213.5	527.3	5.9
Developed	2,557.1	6,316.0	61.0
Cropland	1,962.8	4,848.1	46.8
Pasture	594.3	1,467.9	14.2
Riparian Forest			
Riparian Woodland	269.6	665.9	6.4

Table 3. Quantitative Land Use Changes for 1972-1982 (acres).

Year	Cropland	Pasture	Forest	Urban	Disturbed	Oldfields	Ponds
Broad Study Area							
1972	22,433.8	11,022.4	8,904.4	821.3			
%	51.9	25.5	20.6	1.9			
1979	22,401.2	10,966.5	7,903.8	934.4	8.7	13.0	618.0
%	52.2	25.6	18.5	2.2	0.02	0.03	1.4
1982	22,040.1	11,046.5	7,935.9	966.4	14.8	13.9	770.7
%	51.5	25.8	18.5	2.3	0.03	0.03	1.8
Project Study Area							
1972	4,848.1	1,467.9	4,047.1				
%	46.8	14.2	39.8				
1979	2,446.9	2,159.0	3,890.4	13.3	243.1	1,257.2	203.2
%	23.9	21.1	38.1	0.1	2.4	12.3	2.0
1982	1,084.1	1,975.0	3,078.6	6.2	1,983.2	1,916.0	170.0
%	10.6	19.3	30.1	0.06	19.4	18.8	1.6

Table 4. Habitat quantification for the broad study area, 1979. Values are in acres.

Habitat Type	% Broad Study Area	Acres
Forest		
Woodland	**6.5**	**2,833.6**
Mesquite	1.8	770.0
Oak	3.0	1,315.1
Cedar elm	1.4	610.0
Mesquite/Oak	0.2	86.5
Cedar elm/Mesquite	0.1	43.3
Black Willow	0.02	8.7
Parkland	**3.5**	**1,518.5**
Mesquite	0.2	90.8
Oak	1.1	475.9
Cedar elm	0.2	82.2
Mesquite/Oak	0.4	164.4
Cedar elm/Mesquite	0.1	60.6
Cedar elm/Oak	1.5	635.9
Pecan	0.02	8.7
Shrub Parkland	**0.7**	**320.1**
Mesquite	0.2	77.9
Oak	0.2	90.8
Cedar elm	0.15	64.9
Mesquite/Oak	0.12	51.9
Cedar elm/Mesquite	0.04	17.3
Cedar elm/Oak	0.04	17.3
Savannah	**1.2**	**506.1**
Oak	0.5	229.3
Cedar elm	0.15	64.9
Mesquite/Oak	0.09	38.9
Cedar elm/Mesquite	0.09	38.9
Cedar elm/Oak	0.3	134.1
Shrub/Shrub		
Woodland	**0.2**	**77.9**
Mesquite	0.16	69.2
Mesquite/Oak	0.02	8.7
Parkland	**0.8**	**341.8**
Mesquite	0.7	315.8
Oak	0.03	13.0
Mesquite/Cedar elm	0.03	13.0

Table 4. Continued.

Habitat Type	% Broad Study Area	Acres
Shrub Parkland	**0.5**	**216.3**
Mesquite	0.24	103.8
Oak	0.25	108.2
Mesquite/Cedar elm	0.01	4.3
Savannah	**2.28**	**1,116.1**
Mesquite	2.2	947.4
Oak	0.01	4.3
Cedar elm	0.04	17.3
Mesquite/Oak	0.03	147.1
Developed		
Cropland	51.8	22,343.9
Pasture	25.4	10,966.5
Old field	0.03	13.0
Disturbed	0.02	8.7
Houses	2.2	934.4
Riparian Forest	**2.2**	**973.4**
Woodland	1.7	739.8
Parkland	0.2	86.5
Shrub parkland	0.3	147.1
Riparian Developed	0.9	367.7
Palustrine	1.4	618.0

Table 5. Habitat quantification for the project study area, 1979. Values are in acres.

PROJECT STUDY AREA

Habitat Type	% Fee Lands	Acres
Forest		
Woodland	**15.6**	**1,592.2**
Mesquite	3.2	325.8
Oak	4.1	418.7
Cedar elm	7.2	738.4
Mesquite/Oak	0.3	31.7
Mesquite/Cedar elm	0.2	24.5
Cedar elm/Oak	0.3	27.6
Cedar elm/Pecan	0.2	24.5
Pecan	0.01	1.0
Parkland	**6.1**	**619.9**
Mesquite	0.07	7.7
Oak	1.4	147.5
Cedar elm	1.2	119.3
Mesquite/Oak	0.16	17.0
Mesquite/Cedar elm	1.7	174.7
Cedar elm/Oak	0.06	6.8
Cedar elm/Pecan	0.2	24.6
Pecan	1.2	122.3
Shrub Parkland	**1.3**	**139.9**
Oak	0.13	13.2
Cedar elm	0.42	42.9
Mesquite/Oak	0.08	8.2
Mesquite/Cedar elm	0.74	75.6
Savannah	**1.8**	**189.9**
Mesquite	0.14	15.3
Oak	0.50	51.1
Pecan	1.2	123.5
Shrub/Shrub		
Shrub Parkland		
Mesquite	0.83	85.2
Savannah	**5.6**	**576.0**
Mesquite	3.7	384.0
Cedar elm	0.05	5.1
Mesquite/Cedar elm	1.3	129.7
Mesquite/Oak	0.56	57.2

Table 5. Continued.

PROJECT STUDY AREA

Habitat Type	% Fee Lands	Acres
Developed		
Cropland	23.9	2,446.9
Pasture	21.1	2,159.0
Old field	12.3	1,257.2
Disturbed	2.4	243.1
Houses	0.13	13.3
Riparian Forest		
Woodland	6.7	687.3
Palustrine	2.0	203.2

Table 6. Habitat type quantification of the broad and project study areas, 1979–1982. Habitat types correspond to Maps 1 and 2 (see map pockets). All values are in acres.

	Broad Study Area		% Change	Project Study Area		% Change
Habitat Type	1979	1982	1979–82	1979	1982	1979–82
FOREST	5,178.3	5,229.2	+1.0	2,541.9	2,163.4	-14.9
Woodland	2,833.6	2,833.6	NC*	1,592.2	1,413.6	-11.2
Parkland	1,518.5	1,569.4	+3.3	619.9	464.2	-25.1
Shrub Parkland	320.1	320.1	NC	139.9	102.8	-26.5
Savannah	506.1	506.1	NC	139.9	182.8	-37.7
SHRUB/SHRUB	1,752.1	1.733.3	-1.0	661.2	452.2	-31.6
Woodland	77.9	77.9	NC	0	0	NC
Parkland	341.8	291.2	-14.8	0	0	NC
Shrub Parkland	216.3	255.2	+17.9	85.2	28.4	-33.3
Savannah	1,116.1	1,109.0	-0.6	576.0	423.8	-26.4
DEVELOPED	34,266.5	34,081.7	-0.5	6,119.5	6,964.5	+13.8
Cropland	22,343.9	22,040.1	-1.3	2,446.9	1,084.1	-55.7
Pasture	10,966.5	11,046.5	+0.7	2,159.0	1,975.0	-8.5
Old field	13.0	13.9	+6.9	1,257.2	1,916.0	+52.4
Disturbed	8.7	14.8	+72.1	243.1	1,983.2	+715.6
Houses	934.4	966.4	+3.4	13.3	6.2	-53.4
RIPARIAN FOREST	973.4	973.4	NC	687.3	463.0	-32.6
Woodland	739.8	739.8	NC	687.3	463.0	-32.6
Parkland	86.5	86.5	NC	0	0	NC
Shrub Parkland	147.1	147.1	NC	0	0	NC
RIPARIAN DEVELOPED	367.7	367.7	NC	0	0	NC
PALUSTRINE	618.0	770.7	+24.7	203.2	170.0	-16.3
Excavated	426.4	569.1	+33.5	203.2	170.0	-16.3
Dammed Ponds	191.6	201.6	+5.2	0	0	NC
Totals	43,156.0	43,156.0		10,213.1	10,213.1	

* NC = No change.

of true accuracy for delineated habitat types between 90.7% and 96.1%.

Aerial photographs taken in early October 1982 were analyzed and data compared to that of 1972 and 1979 in order to determine quantitative changes in land use and habitat type alteration within the project and broad study areas. A comparison of data from the broad study area for 1979 and 1982 showed little change in land use or habitat alteration. Urban land use increased 3.4% (32.0 ac = 12.9 ha), disturbed sites (primarily for water well construction) increased 70.1% (6.1 ac = 2.5 ha), and pond construction increased 24.7% (152.7 ac = 61.8 ha). Overall comparison of 1972 to 1982 data revealed that cropland and pasture land use was basically unchanged, whereas, forests decreased 10.9% (968 ac = 392.1 ha), and urban usage increased 17.7% (145.1 ac = 58.7 ha) (primarily in the Whitney area).

Project area data comparisons for 1979 and 1982 showed a 55.7% (1362.8 ac = 551.7 ha) decrease in cropland, 8.5% (184.0 ac = 74.5 ha) decrease in pasture, 14.9% (378.5 ac = 153.2 ha) decrease in forests, and a 53.4% (7.1 ac = 2.9 ha) decrease in urban usage (Table 6). Land clearing within the conservation pool and project facilities construction resulted in 715.6% (1,740.1 ac = 704.5 ha) increase in disturbed areas, and cropland succession showed 52.4% (568.8 ac = 266.7 ha) increase in oldfields. Comparing 1972 and 1982 data revealed that cropland decreased 77.6% (3,764.0 ac = 1,523.9 ha), pasture increased 34.5% (507.1 ac = 205.3 ha), and forests decreased 23.9% (968.5 ac = 392.1 ha). Project area losses of forested habitat types due to lake construction resulted in all forested areas decreasing by an average of 20.9% (811.8 ac = 328.7 ha). Greatest habitat type loss (in terms of species diversity and abundance) resulted from the clearing of approximately 32.6% (224.3 ac = 90.8 ha) of riparian forest in the conservation pool area.

Vegetative Descriptions of Habitat Types

Vegetation descriptions of the habitat types are based on data collected from the 13 sampling grids. Habitat type descriptions correspond to those types quantified in Tables 4 and 5.

Cedar elm Woodland. -- Cedar elm woodlands were found adjacent to riparian forests, usually on slopes of 3-5%. Study site representative of this type was T1-5 (Plate 1). Up-slope soils were Lamar sandy clay loams, moderately alkaline. Soils nearer to bottomland riparian sites were Tinn clays, moderately alkaline, and frequently flooded. The dominant overstory species was cedar elm (*Ulmus crassifolia*). Other overstory species included live oak (*Quercus virginiana*), green ash (*Fraxinus pensylvanica*), western soapberry (*Sapindus drummondii*), osage orange (*Maclura pomifera*), and eastern red cedar (*Juniperus virginiana*). Green ash was the most important understory species, while cedar elm, western soapberry, and honey mesquite (*Prosopis glandulosa*) were of lesser importance. Shrubs were dominated by coralberry (*Symphoricarpos orbiculatus*). Associated shrubs included elbow bush (*Forestiera pubescens*), green-brier (*Smilax bona-nox*), and green ash. Carex (*Carex reniformis*) was the dominant herbaceous species throughout seasonal sampling.

Oak Woodland. -- Oak woodland habitat types were found primarily on upland sites (Plate 1). Soils were Axtell fine sandy loams on 2-5% slopes, strongly acidic, with low permeability. Soil surface was characterized by frequent pebbles, and small stones. Post oak was dominant in the overstory

Plate 1. Above, a cedar elm woodland scene (T1-5), herbaceous component consists primarily of Canada wildrye, June 1980. Below, a view of an oak woodland (near T1-1) showing thicketization, and a sparse herbaceous component, June 1980.

and understory. Honey mesquite, cedar elm, and eastern red cedar were also present in the overstory. Cedar elm could be considered co-dominant in the understory. Associated understory species were blackjack oak, gum bumelia (Bumelia lanuginosa), and honey mesquite. Fragrant sumac (Rhus aromatica) dominated the shrubs, while co-dominants included prickly pear (Opuntia sp.), and elbow bush. Lesser important shrubs were post and blackjack oak, smilax, and tasajillo (Opuntia leptocaulis). A cedar elm invasion was indicated by the large number of cedar elm shrubs in the understory.

Pecan Parkland. — Pecan parkland sites were found adjacent to riparian sites. Study area T3-2 is representative of this habitat type (Plate 2). Soils were Pursley clay loams, alkaline, well drained bottomland sites, and frequently flooded. Pecan (Carya illinoiensis) was the dominant overstory species, with an average circumference of 40.5 in (103 cm); the largest pecan measured had a circumference of 167.7 in (426 cm). Associated overstory species were green ash, honey locust (Gleditsia triacanthos), and box elder (Acer negundo). Cedar elm dominated the understory, while pecan, sugarberry (Celtis laevigata), and osage orange were of lesser importance. Shrub component was dominated by green-brier, having a density of approximately 9,653.8 plants/ac (23,845 plants/ha). Associated shrub species were coralberry, cedar elm, and deciduous holly (Ilex decidua). Carex was the dominant herbaceous species throughout seasonal sampling. Associated herbaceous species include bermudagrass (Cynodon dactylon), green-brier, Canada wildrye (Elymus canadensis), and iron weed (Vernonia baldwinii). Data indicate that this site had been managed for pecans.

Mesquite/cedar elm Parkland. -- Areas with open or closed clusters of trees covering >50% but <75% of the ground were considered parklands. Soils were Konsil fine sandy loams, 3-5% slopes, slightly acidic, occurring on upland sites. This habitat type is represented by T 1-2 (Plate 2). Overstory was dominated by large honey mesquite, and cedar elm with a few large post oak present. Cedar elm dominated the understory. Honey mesquite, sugarberry, hercules-club (Zanthoxylum clava-herculis), and hawthorn (Crataegus sp.) were of lesser importance in the understory. Tasajillo was the dominate shrub species. Associated shrubs were cedar elm, green-brier, elbow bush, and fragrant sumac. Herbaceous level was dominated by Texas wintergrass (Stipa leucotricha), downy brome (Bromus tectorum), Scribners' dichanthelium (Dichanthelium oligosanthes) and little bluestem. The large size of post oak indicated it to have been a former dominant or relict, while cedar elm and honey mesquite have invaded and become permanent occupants.

Mesquite Woodland. — Areas of at least 75% ground cover and with shrubs evenly spaced were considered shrub woodlands. Soils were Axtell fine sandy loams, 2-5% slopes, strongly acidic, on upland sites. Pebbles and small stones characterized the soil surface. Study area T1-1 is representative of this habitat type (Plate 3). The dominant species was honey mesquite with a density of approximately 850.2 shrubs per ac (2,100 shrubs per ha). Herbaceous dominants varied with the seasons, but Texas wintergrass, downy brome, and Texas grama (Bouteloua rigidisetta) were prevalent throughout sampling.

Mesquite Savannah. — Mesquite savannah habitat is an area with widely scattered shrub mesquite, covering 10-25% of the ground. Mesquite savannah is represented by grid of T1-3 (Plate 3). Soils were Lamar sandy clay loams, 3-

Plate 2. Above, view of a pecan parkland (T3-2), herbaceous and shrub components composed primarily of *Smilax*, June 1980. Below, a mesquite/cedar elm parkland scene (T1-2), with herbaceous component of little bluestem, June 1980.

Plate 3. Above, a mesquite woodland scene (T1-1), showing dense mesquite and a herbaceous component dominated by annual broomweed, June 1980. Below, a view of a mesquite savannah (T1-3) with a herbaceous component dominated by little bluestem, June 1980.

5% slopes, moderately alkaline, occurring on upland sites. Increased water runoff caused erosion problems. Other shrubs present were gum bumelia, sugarberry, cedar elm, and hawthorn. Important herbaceous species included kochia (Kochia scoparia), annual broomweed (Xanthocephalum dracunculoides), goldenrod (Solidago altissima), Texas wintergrass, bluebonnet (Lupinus texensis), and sand dropseed (Sporobolus cryptandrus).

Cropland. -- Cultivated areas for row crops used for food or fiber for man or livestock were considered cropland. Agricultural practices centered around dryland farming, both cash crops and livestock. Cotton was the major crop grown on clayey soils and beef cattle production occurred on the shallower soils developed from limestone. Additional cash crops grown were grain sorghum and peanuts on sandier soils. Marginal areas used as cropland have been abandoned or planted to improved grasses. Soil erosion was a major problem, necessitating the use of field terraces and contour tillage.

Pasture. -- Areas with >25% ground cover dominated by grasses and/or forbs with <10.0% canopy cover were considered pasture. Improved pastures were used primarily for growing hay sorghums and bermudagrass. The best pastures were in bottomlands which flooded 2-3 times each year. Hay cutting occurred 2-3 times during summer and fall. Native pasture as a habitat type was non-existent, as these areas have been "improved" with bermudagrass, Johnson grass (Sorghum halepense), and Klein grass (Panicum coloratum), and grazed by domestic livestock. Formerly cultivated acreages that were difficult to cultivate or produced low yields have been turned into improved pasture.

Oldfield Sites. -- Areas which were formerly cultivated fields with >25.0% ground cover and allowed to reseed naturally were considered oldfields (Plate 4). Soils were Silstid loamy fine sands, slightly acid, well drained, gently sloping 1-3% on upland sites. This habitat type was sampled from the bare ground stage of succession until the conclusion of the study. False dandelion (Pyrrhopappus multicaulis) became established on bare ground during winter. Spring warm-up and green-up showed the field to be predominantly false dandelion with a density of 5.1 plants per ft^2 (55.0 plants per m^2). As the seasons progressed, other species became established. Ten species were present at the conclusion of the study; false dandelion was dominant, but sow thistle (Sonchus asper), and goldenrod were becoming established. Japanese brome (Bromus japonicus) and Johnson grass had also become established.

Riparian Woodland. -- Closed stands of trees forming a continuous canopy over at least 75% of the ground and associated with rivers and streams were considered riparian forest habitat. Soils were Tinn clays of flood plains, moderately alkaline, and poorly drained. Flooding occurs 2-3 times each year, during which the water may rise 10-20 ft (3-6 m). Study sites T2-2 and T4-3 were representative of this type (Plate 4). Overstory and understory were dominated by large cedar elms, average circumference of 39.4 in (100 cm). Associated overstory species included western soapberry, green ash, red mulberry (Morus rubra), sugarberry, and pecan. Associated species of the understory were sugarberry, osage orange, western soapberry, and gum bumelia. Dominant shrub species were coralberry and elbow bush. Green-brier, cedar elm, and sugarberry were of lesser importance in the shrub level. Carex and Canada wildrye dominated the herbaceous level for all seasons. Diversity of woody species was greatest of any habitat type sampled.

Plate 4. Above, an oldfield scene (near T1-4) approximately 1-year since abandonment, showing a herbaceous component dominated by false dandelion, June 1980. Below, a riparian woodland scene (T4-[illegible]) with an overstory of cedar elm and green ash, and a herbaceous component of Canada wildrye, June 1980.

Construction Sites/Gravel Pits. — Pits were excavations ranging in size from 2.5 ac (1.0 ha) to 350 ac (141.7 ha), and in depth from 10 ft. (3 m) to 30 ft. (9.1 m). Rock, gravel, sand, and clay have been removed. These areas are well to poorly drained. Numerous ponds result where water runoff has become impounded. Extensive erosion around the sides of the sites caused increased deterioration of the adjoining land. Reclamation of these sites is difficult. This habitat type was found primarily in the vicinity of on-going construction of Aquilla Lake.

Total densities per hectare for each growth form by habitat type and study grid are presented in Table 7 and 8. Seasonal herbaceous densities reflect drought conditions which occurred during the summer of 1980. A comparison of spring and summer data showed that herbaceous vegetation was greatly affected by the summer drought (Table 8). There was a 43.5% reduction in total herbaceous density for the study area. On 2 of 13 grids (T 4-2 and T 1-3) there was an increase in total density of herbaceous vegetation due to the protective canopy of T 4-2, and the high density of annual broomweed on T 1-3. Grid T 2-2 had a dense protective canopy similar to T 4-2, but unlike T 4-2, T 2-2 had a herbaceous component which was predominately Canada wildrye, a cool season grass. Drought conditions resulted in an 82.2% reduction in total herbaceous density for this grid.

Fall rains in late October and November greatly improved the appearance of the study areas. Cool season plants began to recover and on most grids were dominant over the remaining warm season plants. Warm season plants survived in protected areas. Grid 2-1, formerly a Johnson grass pasture, had a density of 27.9 forbs per ft^2 (300 forbs per m^2). Table 8 provides total herbaceous densities for all grids throughout the study. Downy brome and Texas wintergrass were abundant on 6 of 13 grids. These 2 species, in addition to the forbs, caused the drastic increase in total herbaceous density, averaging 96.3 plants per ft^2 (1,035.9 plants per m^2).

Winter cold of February had little effect on reducing the number of early spring species which started new growth during the mild weather of December. On all but 1 grid, the number of herbaceous species per ft^2 increased markedly. Grid T 3-1 showed a 39% decrease in total herbaceous density due to the lack of adequate ground cover which would have provided protection from freezing. Litter present on this grid was at ground level and provided no protection for plants > 7.9 in (>20 cm) in height. Other grids had standing litter >23.6 in (>60 cm) in height which attributed greatly to overwinter survivability of plants. Overall, when compared to fall data, downy brome was the most abundant and important species on 54% of all grids. Texas wintergrass ranked 2nd in importance comprising 30% of all grids. The remaining 16% was comprised of Canada wildrye, carex, and Japanese brome.

Spring sampling for 1981 occurred from April to May in order to collect as many early species as possible. Unknown species were flagged as they sprouted and periodically checked until anthesis. This resulted in an accurate species account, as well as providing densities and coverage values for species easily overlooked. Herbaceous densities were larger than those reported during the spring of 1980, likely due to increased familiarity with various vegetative growth stages.

Appendix D provides densities for each major overstory, understory, and shrub species. Appendix E provides a summary of all vegetation parameters per habitat type. If the size classes of each species are ranked according to basal circumference measurements it is possible to obtain the present status of the woody vegetation (Appendix F). Data from grid T 1-2 shows the presence

Table 7. Total density plants per ac of the woody vegetation for each study grid on the project area (1980-81). Total density (plants per ha) is given in parentheses ( ).

Study Grid	Habitat Type	Growth Form: Overstory	Understory	Shrubs	Total Density
*	Oak Woodland	285.9 (706.1)	596.5 (1,473.4)	1,268.4 (3,133.1)	2,150.8 (5,312.6)
T1-3 2-3	Mesquite Savannah	-	-	151.0 (373.0)	151.0 (373.0)
T1-5	Cedar elm Woodland	209.3 (517.0)	1,284.2 (3,172.0)	4,542.9 (11,221.0)	6,036.4 (14,909.0)
T1-2	Mesquite Cedar elm Parkland	149.4 (369.0)	344.6 (851.3)	988.3 (2,441.01)	1,482.3 (3,661.4)
T2-2 4-2	Riparian Forest	129.3 (319.4)	404.4 (999.0)	2,498.1 (6,170.4)	3,031.8 (7,489.8)
T1-1	Mesquite Woodland	-	-	867.0 (2,141.6)	867.0 (2,141.6)
T3-2	Pecan Parkland	24.3 (59.9)	19.1 (47.2)	9,824.7 (24,267.0)	9,868.1 (24,374.2)

* Oak woodland habitat type was not represented on the 13 study grids, but was sampled due to its abundance on upland sites.

Table 8. Estimated total seasonal herbaceous density per ft^2 for each habitat type (1980-81). Density per m^2 is in parentheses ( ).

Study Grid	Habitat Type	Summer 1980	Fall 1980	Winter 1980	Spring 1981	Average Density
*	Oak Woodland	(19.3) 1.8	(9.8) 0.9	(7.8) 0.7	(28.8) 2.7	(16.4) 1.5
T1-5	Cedar elm Woodland	(49.3) 4.6	(30.0) 2.8	(90.2) 8.4	(76.2) 7.1	(61.4) 5.7
T1-1	Mesquite Woodland	(31.5) 2.9	(246.0) 22.9	(1,364.7) 126.8	(433.3) 40.3	(518.9) 48.2
T1-2	Mesquite Cedar elm Parkland	(27.3) 2.5	(569.5) 52.9	(509.0) 47.3	(520.3) 48.4	(406.5) 37.8
T3-2	Pecan Parkland	(80.5) 7.5	(208.7) 19.4	(150.5) 14.0	(180.2) 16.7	(155.0) 14.4
T1-3 2-3	Mesquite Savannah	(81.8) 7.6	(91.2) 8.5	(351.0) 32.6	(658.6) 61.2	(295.7) 27.5
T2-2 4-2	Riparian Woodland	(25.7) 2.4	(86.5) 8.0	(219.7) 20.4	(180.0) 16.7	(128.0) 11.9
*	Oldfield	(37.7) 3.5	(55.5) 5.1	(56.0) 5.2	(57.7) 5.3	(51.7) 4.8

* Oak woodland and oldfield habitat types were not represented in the 13 study grids, but were sampled due to their abundance within the project area.

of a cedar elm invasion as evidenced by the presence of a large percentage (58%) of the smaller size class. Marked contrast to this can be seen by comparing grid T 1-2 to the stable size class distribution of cedar elm on grids T 1-5, 1-6, and 4-2. Although T 2-2 has a stable size class distribution in the overstory, it is evident that western soapberry is invading the understory. Table 9 provides the dominant and co-dominant overstory, understory, and shrub species for all grids. Dominant overstory and understory species for the area was cedar elm, while honey mesquite was the dominant shrub.

Terrestrial Wildlife Resources

Diurnal raptors were most commonly observed in all seasons in open habitats, pasture, and cropland (Fig. 11). Riparian woodland areas generally had the next most abundant observations, followed by forest parkland habitats. Observed preferences for open habitats may reflect better observational opportunities in open fields than in wooded habitats. These preferences may also reflect the importance of open areas for foraging by the most common diurnal raptors (marsh hawks, red-tailed hawks, and turkey vultures). Prey animals and/or carrion would probably be more visible to these birds in open habitats.

The habitat types with the greatest species richness were pasture and cropland. A total of 11 species of raptors were observed in these types with a species diversity value of 3.95 (Fig. 11). Seven species were observed in forest parkland with a species diversity value of 3.13. Riparian woodland produced 6 species and a species diversity value of 2.35. These values are comprehensive values and do not consider seasonal variations in the diversity within the habitats. It is evident that species diversity as calculated, does not correspond with absolute abundance. The diversity index adjusts for both the total number of individuals and the number of species observed. Abundance data reflects an orientation toward the total number of individuals observed. Individual species abundance fluctuated with the seasons.

Red-tailed hawks, marsh hawks, and white-tailed kites were confirmed nesters on the study area. Turkey vultures, red-shouldered hawks, and black vultures possibly nested in the vicinity of the study area. Red-tailed hawks initiated nesting activity in February. Most of the wintering individuals migrated out of the area in spring. Those birds that remained over the summer seemed to include both nesting pairs and nonbreeding individuals. The small resident population was augmented by fall migrants and a substantial number of red-tailed hawks were observed in winter.

Red-shouldered hawks were resident in small numbers along the riparian woodland areas of the study area. They were more frequently observed in late summer, and early fall as apparent family groups dispersed away from possible breeding sites.

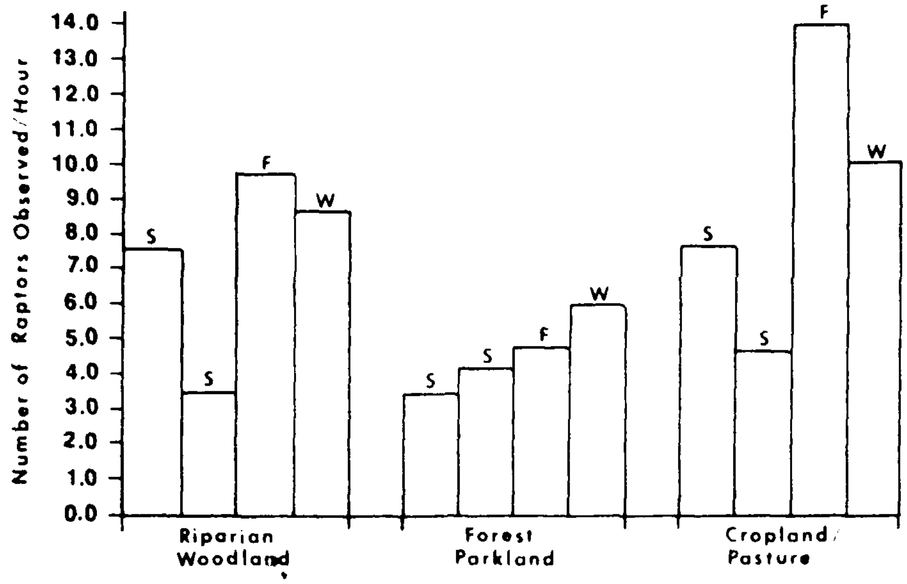
Marsh hawks were commonly observed over open habitat types throughout the study area. The population peaked in fall as migrants moved into the area. Some of these birds probably remained on the area throughout the winter. A confirmed nesting pair fledged 5 young from an old field area along transect #1.

American kestrels were not residents on the area. They were common spring and fall migrants. Wintering birds were most often found in open habitats where they had a clear foraging area. Most of the wintering birds were males.

Table 9. Dominant and co-dominant species* for all grids. In the absence of a co-dominant species, no species is listed (1980-81).

Grid	Overstory	Understory	Srubs
1-1	None	None	Prosopis glandulosa
1-2	Prosopis glandulosa	Ulmus crassifolia	Opuntia leptocaulis
	*Ulmus crassifolia	Prosopis glandulosa	Ulmus crassifolia
1-3	None	None	Prosopis glandulosa
1-4	None	None	None
1-5	Ulmus crassifolia	Ulmus crassifolia	Symphoricarpos orbiculatus
	Celtis laevigata	Celtis laevigata	Forestiera pubescens
1-6	Ulmus crassifolia	Ulmus crassifolia	Forestiera pubescens
	Quercus stellata	Crataegus sp.	Symphoricarpos orbiculatus
2-1	None	None	None
2-2	Ulmus crassifolia	Sapindus drummondii	Smilax bona-nox
	Celtis laevigata	Ulmus crassifolia	Symphoricarpos orbiculatus
2-3	None	None	Prosopis glandulosa
3-1	None	None	Prosopis glandulosa
3-2	Carya illinoinensis	Ilex decidua	Smilax bona-nox
	Fraxinus texensis	Ulmus crassifolia	Symphoricarpos orbiculatus
4-1	None	None	None
4-2	Ulmus crassifolia	Fraxinus texensis	Symphoricarpos orbiculatus
	Quercus virginiana	Ulmus crassifolia	Foresteria pubescens

* Co-dominant species are listed after dominant species.



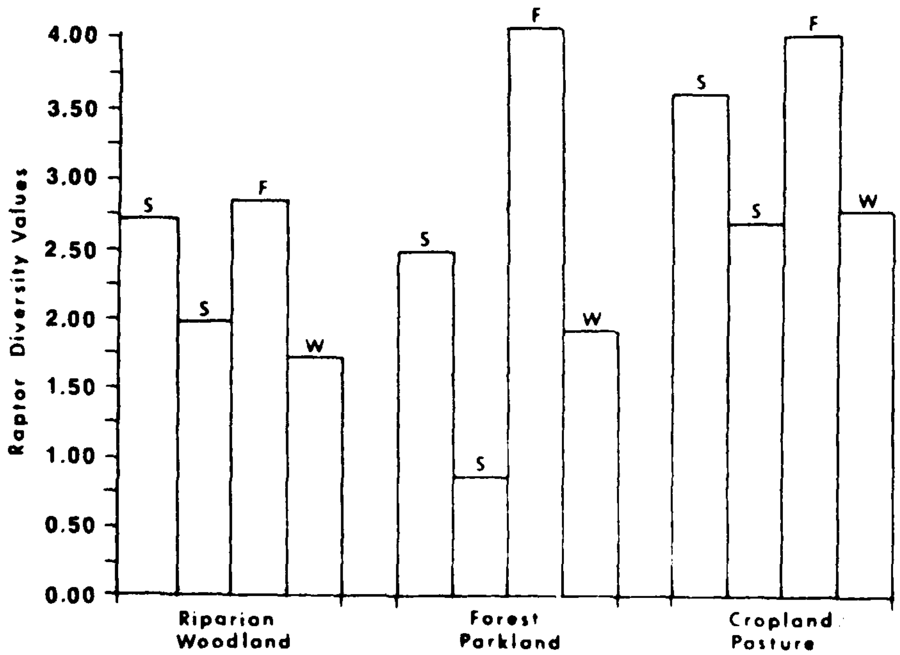


Figure 11. Seasonal variations in raptor abundance and diversity values by habitat type, 1980-1981.

Swainson's hawks and Mississippi kites were observed during spring and fall migration. Both of these species migrated in loose flocks over a period of several days. Swainson's hawks seemed to prefer the open habitat types of the Blackland Prairie, while Mississippi kites were most often observed in forest parkland habitat types of the Eastern Cross Timbers.

White-tailed kites were uncommon to rare residents. They were most often observed in trees along the edges of open habitat types where foraging activity occurred. One pair of white-tailed kites nested and fledged 3 young.

Broad-winged hawks were rarely observed on the area. Incidental observations indicated that broad-winged hawks seemed to prefer wooded habitat types, especially riparian areas. There may have been scattered nesting attempts on the project site.

One peregrine falcon was observed during the winter. This bird may have been a wintering bird, but was more likely an early spring migrant. Other raptors that were observed very rarely were: rough-legged hawks, sharp-shinned hawks, and Cooper's hawks. These birds were probably migrants when observed, although it is possible that 1 or 2 rough-legged hawks may have wintered on the area.

Turkey vultures were by far the most commonly observed raptor on the study area. They were common residents and undoubtedly nested there. They were most commonly observed in open habitat types, usually soaring overhead. However, sightings of birds "sunning" themselves, and roosting were not uncommon.

In general, forest habitat types were more productive for owls than open habitat types. Open habitat types did yield owl observations when overgrown fence rows were nearby. Habitat types sampled in the owl survey were: forest parkland, riparian woodland, pasture and cropland, and shrub parkland (Figure 12).

Owl responses remained fairly consistent in the riparian woodland through the spring, summer, and fall. An increase in responses was recorded in winter. Since many owls are early nesters, this increased vocal activity may have indicated preliminary courtship or nesting behavior. Species diversity values were lowest in summer and highest in winter (Figure 12). The low summer values probably reflect lower activity and vocalizations than could be expected when newly fledged young are active. Calculated diversity values by habitat were: pasture and cropland (2.65); riparian woodland (2.19); forest parkland (2.13); and shrub parkland (1.51). The open habitat types yielded the high diversity values, in part, because a greater number of species were observed in these habitats.

Great horned owls and barn owls were confirmed nesters on the study area. In early summer 1980, 2 great horned owl young were fledged from a nest in a forest parkland habitat type (T 3-2). This nest site was again occupied by an incubating great horned owl in spring 1981. A barn owl nest was discovered in an abandoned shed in another forest parkland habitat type in September 1980. At least 5 young were fledged from this site. Barred owls undoubtedly nested on the area and were the most commonly observed species in all seasons. Two young, recently fledged, were observed in 1980 in a forest parkland habitat type. Screech owls were probable breeders on the area although no confirmed nesting activity was observed. Burrowing owls and short-eared owls were probably migrants.

Abundance values by season (Fig. 13) for diurnal raptors demonstrates the importance of marsh hawks, red-tailed hawks, and turkey vultures in fall and winter seasons. Although all 3 species were known (or suspected) to nest on the project study area , the sharp difference between spring and winter

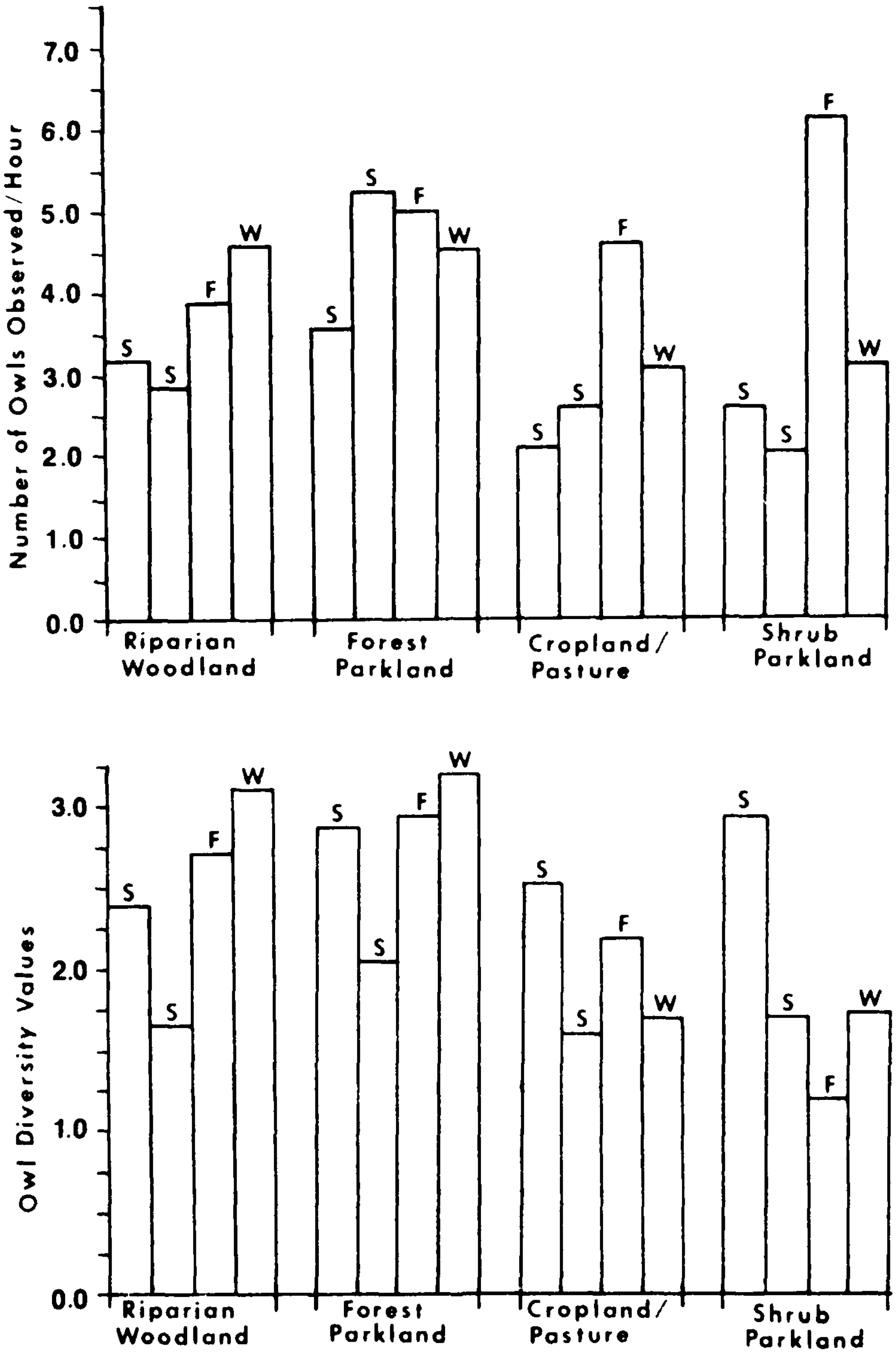


Figure 12. Seasonal variation in owl abundance and diversity values by habitat type, 1980-1981.

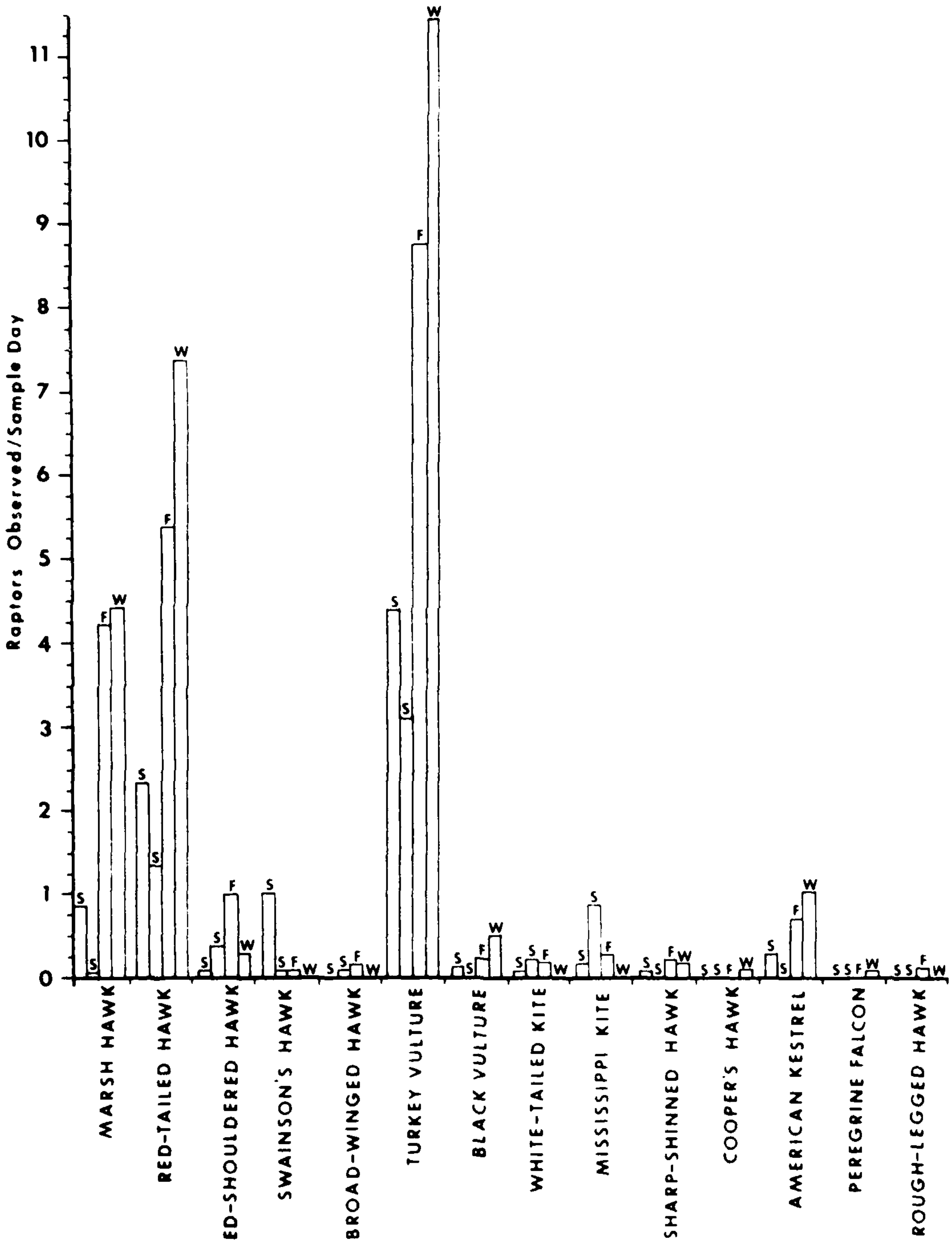


Figure 13. Raptor seasonal variation by species, 1980-1981.

values sugest that the bulk of the population is composed of wintering birds.

Owl abundance values (Fig. 14) show that barred owls were the most common species in all seasons. Peak owl numbers observed in late fall and winter apparently reflects increased call response associated with early nesting resident birds.

There was a higher mean incidence of both mourning doves and bobwhite quail on the ECT route. However, Student's t-test for difference between means yielded no significant difference between the two routes. The BP route contained a higher proportion of cultivated cropland sites than did the ECT route which was more varied (Table 10).

The overall mean number of mourning doves heard calling on a 20 mi (32.4 km) call count route on the study area was 23. The mean number of bobwhite detected on the same routes was 40 birds per 20 mi (32.4 km) route. In all 201 species of birds were observed on the study area (Appendix P). Not all of these were observed on the transects, as this total includes incidental sightings of birds not observed during formal census periods.

Mean density values per key species per habitat type (per 100 ac) are given in Table 11. This value represents the mean density for each species in each habitat type over 4 seasons. Where no value is given for a particular habitat type, the species was not a key species in that habitat.

In addition to raptors, owls, and gamebirds the key species selected for each habitat were: old field - eastern meadowlark, dickcissel, savannah sparrow, vesper sparrow, swallows, loggerhead shrike, song sparrow, and blackbirds; riparian woodland - downy woodpecker, blue jay, Carolina chickadee, tufted titmouse, wrens, yellow-rumped warbler, Harris' sparrow, white-throated sparrow and yellow-billed cuckoo; cropland - swallows, loggerhead shrike, eastern meadowlark, blackbirds, dickcissel, savannah sparrow, vesper's sparrow, and killdeer; pasture - eastern meadowlark, cattle egret, scissor-tailed flycatcher, loggerhead shrike, vesper sparrow, blackbirds, upland sandpiper, and savannah sparrow; forest parkland - blue jay, Carolina chickadee, wrens, tufted titmouse, white-throated sparrow, yellow-billed cuckoo, downy woodpecker and Harris' sparrow; shrub parkland - yellow-billed cuckoo, Carolina chickadee, blue jay, tufted titmouse, wrens, Harris' sparrow, white-throated sparrow, brown-headed cowbird, and indigo bunting.

Species diversity values for each major habitat type when ranked from most diverse to least diverse showed that riparian woodland had the greatest species diversity and pasture had the smallest diversity value. Diversity values by habitat type are:

1. Riparian woodland - d = 25.45
2. Oldfield - d = 23.73
3. Shrub parkland - d = 21.10
4. Cropland - d = 15.37
5. Forest parkland - d = 14.56
6. Pasture - d = 10.49

Diversity values should be used as a measure of a habitat's ability to

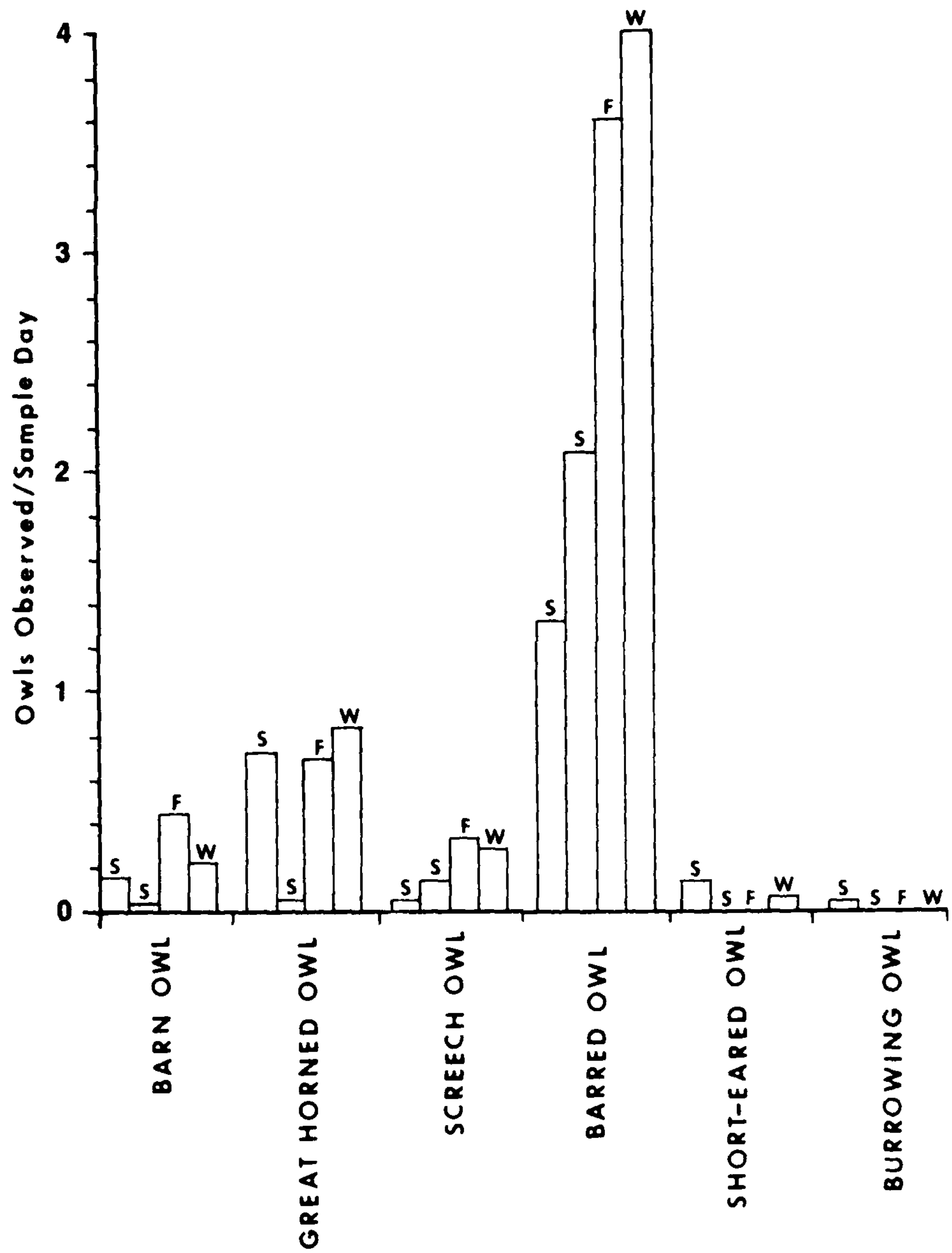


Figure 14. Owl seasonal variation by species, 1980-1981.

Table 10. Habitat variations between Blackland Prairie and Cross Timbers gamebird call count routes (1980-81).

Blackland Number of Stations	Habitat Type	Cross Timbers Numbers of Stations
25	Cultivated Cropland	7
9	Pasture	8
3	Farmstead (structure)	1
2	Riparian Woodland	2
1	Urban (structure)	0
0	Forest Parkland	8
0	Shrub Parkland	14

Table 11. Mean density values for key bird species by major habitat type (1980-81).*

Species	Shrub Parkland	Forest Parkland	Riparian Woodland	Cropland	Pasture	Old Field
Vultures	4	trace	5	trace	5	trace
Hawks	15	2	3	1	33	2
Owls	0	trace	3	trace	0	0
Bobwhite	27	2	24	1	4	trace
Mourning Dove	63	4	11	trace	13	2
American crow	57	3	28	trace	9	trace
Cardinal	208	56	86	trace	11	2
Blackbirds				31	186	1
Eastern Meadowlark				10	502	21
Savannah Sparrow				8	44	17
Vesper Sparrow				3	13	11
Loggerhead Shrike				trace	5	trace
Swallows				2		2
Killdeer				1		
Scissor-tailed Flycatcher					3	
Cattle Egret					4	
Upland Sandpiper					2	
Song Sparrow						1
Dickcissel				5		
Downy Woodpecker		2	7			
Yellow-billed Cuckoo	5	1	6			
Carolina Chickadee	76	7	31			
Blue Jay	35	2	8			

Table 11. Continued.

Species	Shrub Parkland	Forest Parkland	Riparian Woodland	Cropland	Pasture	Old Field
Tufted Titmouse	13	2	7			
wrens	25	2	11			
Harris' Sparrow	63	9	67			
White-throated Sparrow	trace	3	107			
Yellow-rumped Warbler			18			
Brown-headed Cowbird	36					
Indigo Bunting	12					

* All data are presented in a rounded density value per 100 ac (40 ha).

meet species needs. Both density and diversity estimates will vary with the season. Diversity and density values presented above are averages for an entire year's sampling effort.

Among waterfowl only wood ducks were known to nest on the project study area. The remaining waterfowl were most common during migration and winter seasons. The most abundant waterfowl were green-winged and blue-winged teal (Table 12).

Mammalian data analysis for the 5 quarters showed 928 rodents and 1 insectivore were captured during 5,246 trap nights with a total trap success of 17.7% (Table 13). Trap success by species and habitat type is given in Appendix E. Eleven species of rodents and 1 species of insectivore were captured. Voucher specimens were retained and deposited in the Texas Cooperative Wildlife Collections at Texas A&M University. These specimens include study skins, alcohol preserved specimens, complete skeletons, and skulls.

Fifty percent (N=465) of the small mammals captured on grids were cotton rats (Sigmodon hispidus) and 32.2% (N=299) were Peromyscus sp. These 2 rodents comprised over 82% of all small mammals captured (Table 14). Analysis of the mammalian communities indicates that for sites with tall, heavy herbaceous cover cotton rats were the most common (e.g. grids 1-3, 1-4, 1-6) mammals captured. On areas with sparce herbaceous cover (e.g. 3-2, 1-1, and 4-2) Peromyscus sp. predominated. A further comparison of communities was made using the R_O similarity index described by Horn (1966). The range of the R_O index values varies from 0.662 to 0.971 with a value of 1 representing complete similarity and a value of 0, complete dissimilarity. R_O values by habitat type and sampling quarter are given in Appendix G. The R_O values which compare the different habitat types within a given quarter are greater than those which compare the same habitat type in different quarters. We conclude that with respect to the small mammal community, there is less variation due to habitat type then there is due to seasonal differences in a given habitat type. High similarity values may also be an artifact of edge effects as well as the overwhelming representation by 2 ubiquitous forms (cotton rats and Peromyscus sp.). These high R_O values are in contrast to similarity index values reported for North American grasslands where values among site comparisons ranged from 0.09 to 0.69 (Grant and Birney 1979).

In terms of small mammal usage, the parkland/woodland appears to be the most critical. The parkland/woodland habitat type had only 35.68% of the trap effort, while 77.78% (N=7) of the Florida woodrat (Neotoma floridana), 100% (N=1) of the plains harvest mouse (Reithrodontomys montanus), and 50% (N=1) of the least shrew (Cryptotis parva) were trapped there. Further the only known specimen of the pine vole (Microtus pinetorum) for Hill County was collected by Arthur Cleveland of Texas Wesleyan University (pers. comm.) in a similar habitat type northwest of the broad study area. The next most important habitat type in terms of species separation, appeared to be pasture which had 25.67% of the trapping effort, and produced 45.45% (N=10) of the pygmy mouse (Baiomys taylori) and 100% (N=4) of the thirteen-lined ground squirrel (Spermophilus tridecemlineatus) (these 4 animals were all taken at site 2-3). Mammals observed along each transect are presented in Table 15.

Observations on 6-26 mi (9.6-41.6 km) dawn or dusk drive routes on the project study area during the summer of 1980 resulted in 195 mammal sightings, of which 91.3% (N=178) were eastern cottontails (Sylvilagus floridanus). The remaining sightings were as follows: 8 domestic cats (Felis catus), 4 fox squirrels (Sciurus niger), 2 hispid cotton rats, 1 raccoon (Procyon lotor), 1 striped skunk (Mephitis mephitis), and 1 gray squirrel (Sciurus carolinensis).

Table 12. Summary of waterfowl observed on the project study area (1980-81).

Species	Season			
	Spring	Summer	Fall	Winter
Canada Goose	U		U	U
Mallard	C		C	C
Gadwall	C			C
Pintail				C
Green-winged Teal	A		A	C
Blue-winged Teal	A	U		U
American Widgeon				C
Northern Shoveler	C		C	U
Wood Duck	C		U	U
Canvasback			U	
Lesser Scaup				C
Common Goldeneye			R	
Bufflehead			U	
Ruddy Duck	U			U
Hooded Merganser				U
Red-breasted Merganser				R

A = abundant - seen on every visit to the proper habitat in the proper season.

C = common - seen >50% of visits to the proper habitat in the proper season.

U = uncommon - expected, but seen 10-50% of visits to proper habitat in proper season.

R = rare - unexpected, but occurred in small numbers or occasionally during the proper season.

Table 13. Trap success of small mammals in relation to major habitat type (1980-81).

Habitat by Grid	Total Capture	Trap Nights	% Capture Success	% of Trapping Effort
Pasture 1-3,2-3,3-1	230	1,346	17.09	25.[illegible]
Cropland 1-4,2-1,4-1	218	1,020	21.37	19.44
Riparian Woodland 1-5,2-2,4-2	187	1,008	18.55	19.22
Parkland Woodland 1-1,1-2,1-6, 3-2	293	1,872	15.65	35.68
Total	928	5,246	17.69	100.00

Table 14. Trap success, total number of small mammals caught, and percent of total by species (1980-81).

Species	Trap Success	Total No. of Animals	% of Total
Hispid Cotton Rat *Sigmodon hispidus*	.0884	464	50.00
Peromyscus sp.	.0570	299	32.22
Fulvous Harvest Mouse *Reithrodontomys fulvescens*	.0090	47	5.06
Florida wood rat *Neotoma floridana*	.0017	9	0.97
Hispid Pocket Mouse *Perognathus hispidus*	.0074	39	4.20
House Mouse *Mus musculus*	.0076	40	4.31
Black Rat *Rattus rattus*	.0002	1	0.11
Thirteen-lined Ground Squirrel *Spermophilus tridecemlineatus*	.0008	4	0.43
Pygmy Mouse *Baiomys taylori*	.0042	22	2.37
Plains Harvest Mouse *Reithrodontomys montanus*	.0002	1	0.11
Least Shrew *Cryptotis parva*	.0004	2	0.22
Total	.1769	928	100.00

Table 15. Miscellaneous large mammals observed on the project study area (1980-81).

Species		Number Seen	Habitat Type	% of Observations
Cottontail		16	Riparian	
		91	Forest	
		5	Pasture	56.3
		7	Cropland	
	Total	120		
Jackrabbit		5	Forest	
		1	Cropland	2.8
	Total	6		
Fox Squirrel		5	Forest	2.3
Striped Skunk		1	Riparian	
		14	Forest	
		6	Pasture	16.9
		15	Cropland	
	Total	36		
Hognosed Skunk		1	Forest	0.5
Armadillo		4	Forest	
		2	Pasture	2.8
	Total	6		
Red Fox		2	Forest	0.9
Opossum		1	Riparian	
		1	Forest	1.9
		2	Cropland	
	Total	4		
Coyote		8	Riparian	
		15	Forest	14.2
		4	Pasture	
		3	Cropland	
	Total	30		
Bobcat		1	Cropland	0.5
Mountain Lion		1	Riparian	0.5
White-tailed Deer		1	Riparian	0.5

The preponderance of eastern cottontail sightings on drive routes corroborate the high proportion of eastern cottontail observations along transects (Table 15). Numerous road-kills were observed on the project study area. The incidence of road-killed eastern cottontails, striped skunks, opossums (Didelphus virginiana), and armadillos (Dasypus novemcinctus) provide evidence of a high relative abundance for these species.

Capture and identification of amphibians and reptiles produced 1 salamander, 5 turtles, 4 lizards, 2 skinks, 12 snakes, 3 toads, and 4 frogs. The most common species observed, based on visual sightings, were red-eared turtle (Chrysemys scripta), Texas spiny lizard (Sceloporus olivaceous), Texas rat snake (Elaphe obsoleta), Gulf Coast toad (Bufo valliceps), and bullfrog (Rana catesbeiana).

Recreational use of the project study site was limited to hunting (Table 16). Coon hunting was the principal consumptive use occurring primarily in fall and winter. Large groups of coon hunters (N=10-25) would arrive on weekends, campout, and hunted throughout the night. Other hunting uses included upland gamebirds and small mammals. Hunting was primarily restricted to woodland and riparian habitat along Aquilla Creek. Quail hunters were observed near Hackberry Creek on 1 occasion. Several instances of shooting occurred, but the intent of the activity was undetermined. Hunting from a moving vehicle was observed during the spring. Landowners complained of occasional "outlaw" target shooting on project lands near private holdings. No direct observations of these activities were ever observed by project personnel. Data on recreational use of specific project lands by hunters are not maintained by Texas Parks and Wildlife Department.

Aquatic Resources

Discharge directly follows precipitation and is higher in winter and spring and lower in summer. Discharge data for 1980 are shown in Figure 15, along with the average for the past 18 years. The data are from US Geological Survey station 80935, on FM 1304 near the town of Aquilla. Although the April and May discharges were high, the year generally was below average.

The very short spate duration of the creek is a significant factor in interpreting physical-chemical data. The month of May had the highest discharge for 1980, 30,310 acre-feet. The daily discharge for May is given in Figure 16. Note that the vertical scale is the cube root, which drastically foreshortens the peak values. Forty percent of the month's discharge came on one day, the 16th, and 73 % on the 15th, 16th and 17th. Most field sampling (including that for this study) is done between spates, and thus represents base flow conditions only, and the data are not valid for studies of watershed-stream transport relationships or for mass balance studies. Only by using continuous sampling devices or by taking daily water quality samples can the total transport of the stream be evaluated. The USGS station at Aquilla provides continuous recording of discharge, specific conductance, and temperature. Water quality data were taken at the station several times a year, and monthly means for some parameters were calculated from regression relationships with specific conductance.

Some valid seasonal comparisons and comparisons between tributaries can be made from the base flow sampling. Appendix H shows modified Maucha diagrams comparing Aquilla with the Brazos and with mean North American river waters for 1979. The Brazos is very high in total ionic concentration, with Na^+ and Cl^- principal contributors. Aquilla is intermediate in total ionic

Table 16. Hunters use of the project study area during 1980-81.

Season	Date Seen	Habitat Type	Activity
Spring	03/08/80	Cropland	Shooting
	05/23/83	Riparian	Coon hunters
Summer	none		
Fall	09/06/80	Forest	Coon hunters
	09/19/80	Forest	Dove hunters
	10/25/80	Riparian	Quail hunters
	11/01/80	Forest	Varmint hunters
Winter	12/06/80	Forest	Shooting
	12/07/80	Pasture	Shooting
	01/24/81	Forest	Coon hunters
	02/07/81	Cropland	Shooting
	02/21/81	Riparian	Coon hunters

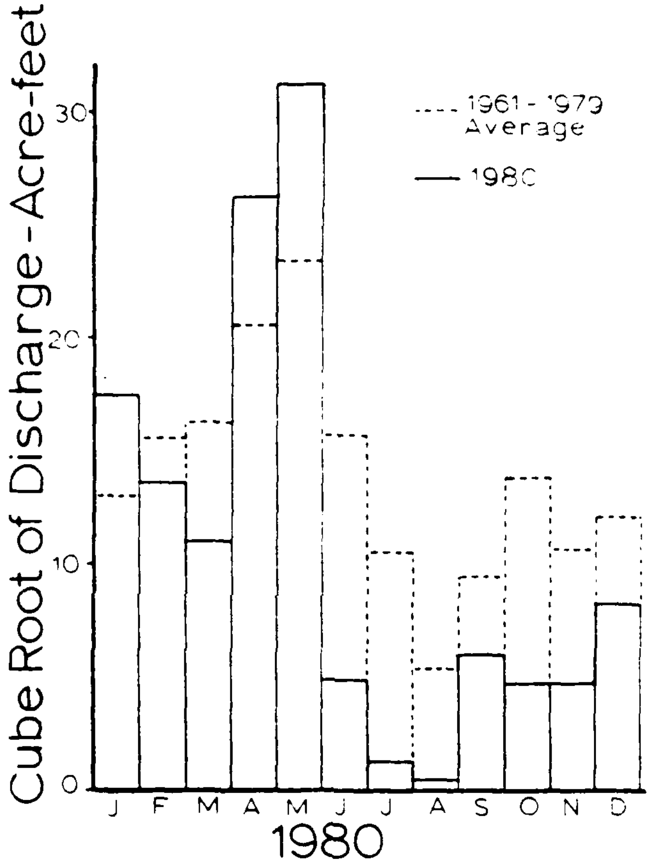


Figure 15. Monthly discharge in acre-feet for 1980, and mean monthly discharge for 1961-1979.

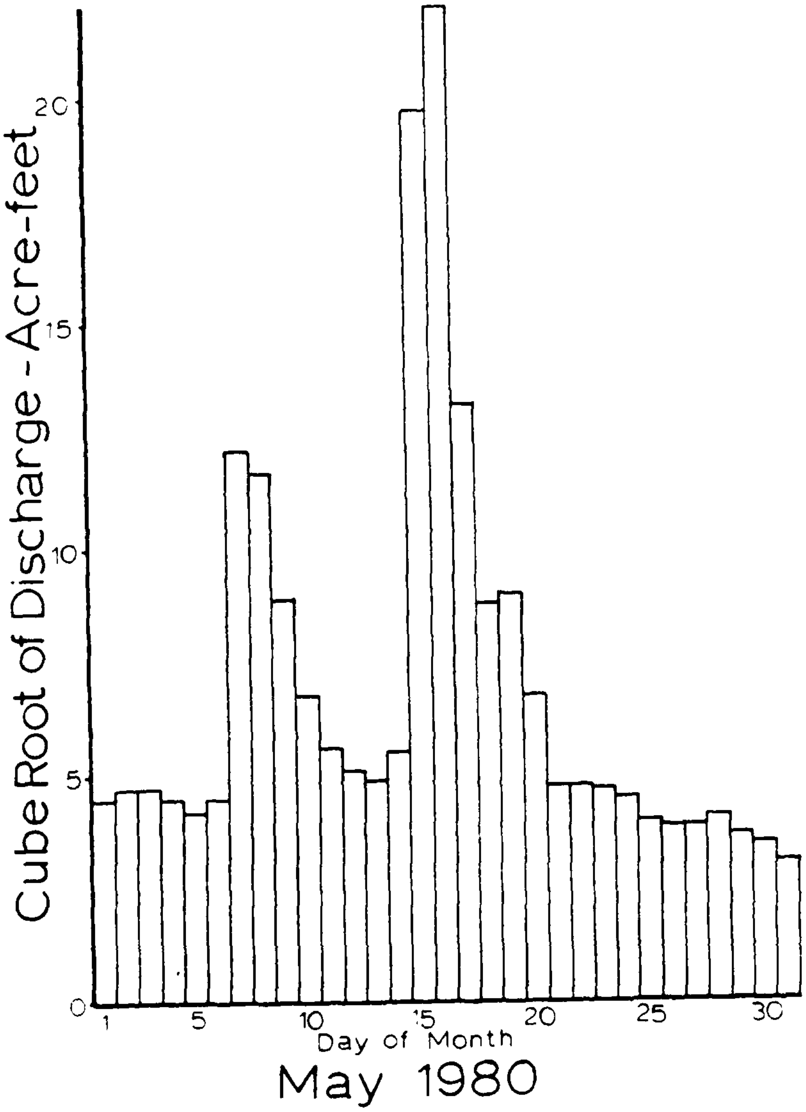


Figure 16. Daily discharge in acre-feet for May 1980.

concentration, with Na^+ and $SO_4^=$ contributing proportionally more than in the mean river waters.

In general, Hackberry Creek (Station A) reflects the effect of its major base flow water source, the Hillsboro sewage treatment lagoon; nutrients are higher, oxygen deficit more pronounced. Late summer and fall show the highest nutrient levels and associated chlorophyll a values. Both ammonia and total phosphorous were at maximum levels at station A in August, while nitrate was at its minimum. This was at a time when discharge was a minimum and the total base flow came from the Hillsboro sewage treatment pond. Under these conditions abundant periphyton may have taken up the available nitrate. The consistently higher pH of Hackberry probably relfects watershed soil characteristics.

A complete checklist of organisms collected and combined quarterly biological data are given in Appendix I.

A general summary (Appendix J) shows a greater number of taxa in the riffles, but higher densities (in numbers) in the pools, a result which is in agreement with stream ecology principles. Station A on nutrient rich Hackberry Creek shows highest pool densities and station E the highest riffle densities. Station E has good riffle substrate, (better than station C) and both of these lower stations have year round flow. This flow stability is also reflected in the higher number of taxa at these stations.

Occurrence and relative abundance for major taxa are shown in Figures 17 and 18. Figure 17 shows all major forms except midges, which, because of their importance and diversity, are shown separately in Figure 18. The introduced pelecypod, <u>Corbicua</u>, is present at the lowest station, and can be expected to spread upsteam. Oligochaetes dominate the pool biota, with midge larvae next in importance. The occurrence of other forms is erratic.

In the riffles the dominant midge larvae and oligochaetes are joined by sphaerid clams, mayfliesres 17 and 18. Figure 17 shows all major forms except midges, which, because of their importance and diversity, are shown separately in Figure 18. The introduced pelecypod, <u>Corbicua</u>, is present at the lowest station, and can be expected to spread upsteam. Oligochaetes dominate the pool biota, with midge larvae next in importance. The occurrence of other forms is erratic.

In the riffles the dominant midge larvae and oligochaetes are joined by sphaerid clams, mayfliesls, caddisflies and beetles.

There is nothing unusual in the composition or distribution of the benthos (Appendix K).

The percentage of stream bed occupied by water ranged from 0.4 to 99%. In general, the amount of water present was surprisingly great, in view of the extremely dry weather that preceded the survey. Water was present throughout the bed from the highest section walked-out to the confluence with Aquilla Creek. The large amount of water in section 5 may be attributed to: 1) a temporary dam built across the stream bed at the construction site; and/or 2) a different soil type which first appeared at the lowest section. The soils for the upper 4 sections are permeable sandy soils; while the soils of the lowest sections are clayey and much less permeable.

The observed structure of the exposed (dry) channel of Aquilla Creek indicated that at some sections considerable erosion and deposition had occurred when the stream was flowing. On some of the upper stretches in sandy soils, large beds of fine gravel 3.3-4.9 ft (1-1.5 m) high and 6.5-9.8 ft (2-3 m) wide were found on the inside of bends in the channel with considerable undercutting evident on the outside of the bends. Other stretches of the stream appeared to have more stable channels composed of hard clay bottoms and

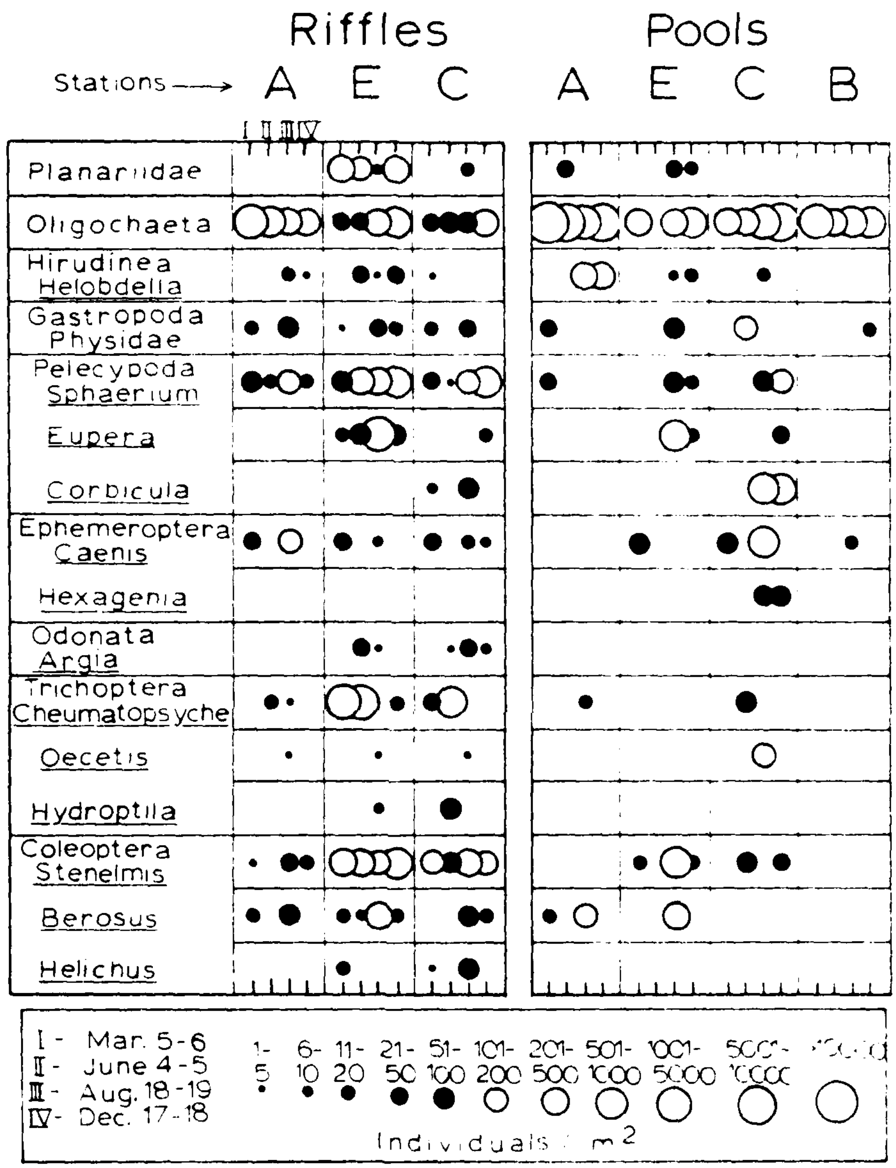


Figure 17. Densities of major macroinvertebrate taxa other than Diptera at sampling stations on Aquilla and Hackberry creeks for quarterly sampling dates during 1980.

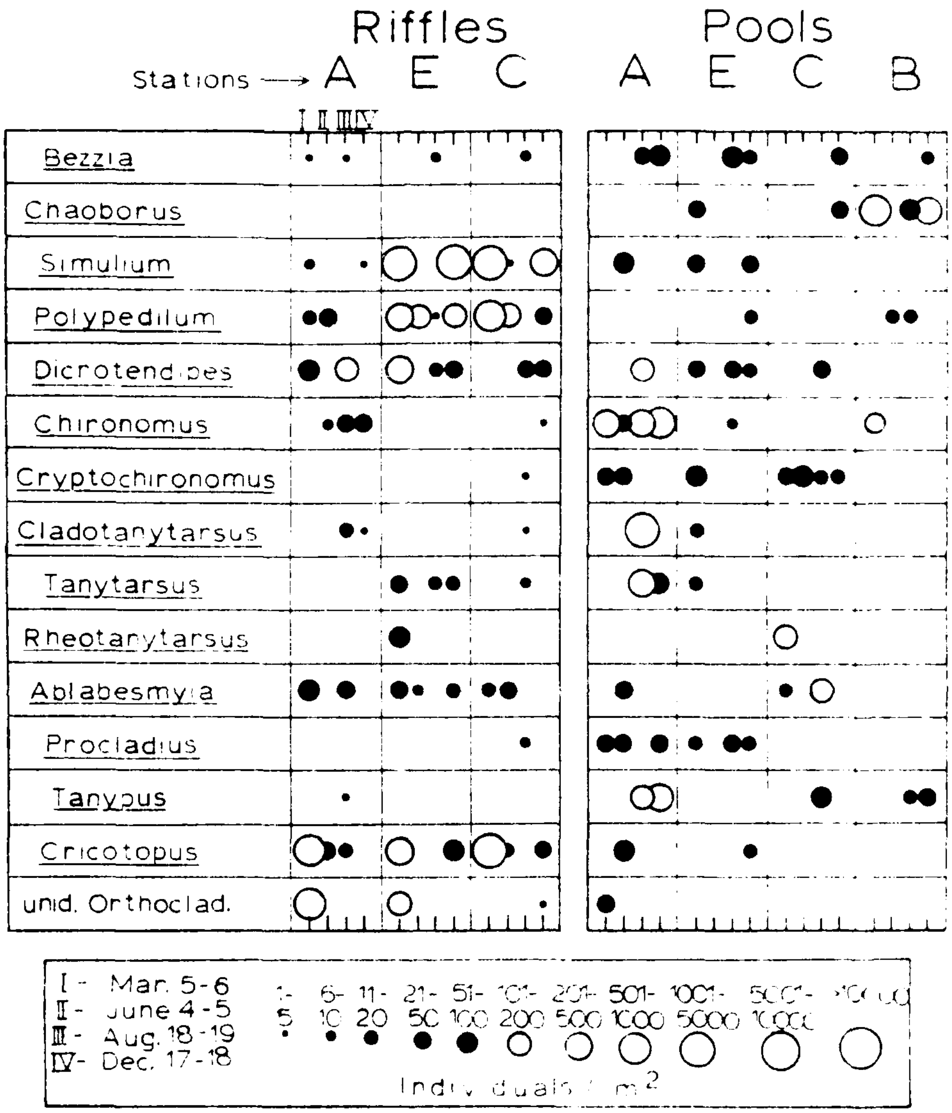


Figure 18. Densities of major genera of Diptera for sampling stations on Aquilla and Hackberry creeks for quarterly sampling dates during 1980.

banks. Some restricted stretches of stream passed through exposed bedrock.

The observed path of the stream channel appeared markedly similar to the pattern indicated on the 1957 topographic map, although it is doubtful that the locations of pools stay the same from year to year, especially in the areas where considerable movement of bed-load was evident. The stream has very steep banks over much of its length, which would give stability to stream channel locations.

Pools were often located where trees had been deposited across the channel and had accumulated debris and trapped gravel. One long pool observed downstream from Hwy 22 was apparently formed by a beaver (Castor canadensis) dam. Fresh signs indicated that a beaver was living in the area. Some pools were found in depressions (due to scour?) on the stream bottom. On the lower reaches, in clayey soils, many long continuous pools were found which were interrupted only by occasional log jams on which soil, trash, and other debris had accumulated.

Physical-chemical data are summarized in Appendix L. The stream was well shaded over most of its observed length and water temperatures were always a few degrees less than the air temperatures in the adjacent areas. Temperatures were taken in selected pools, and ranged from 78.8-82.4^{o}F (26-28^{o}C). The pH of the pool waters ranged from 7.2 to 7.7. Conductivities ranged from 1000 to 2500 micromhos, but most were near 1200 micromhos. Standing water at the end of a long pool near the construction site had a pH of 8.1. Many of the pools were anoxic; H_2S was detected and bottom material was very dark.

The physical appearances of pools in a given stretch of stream were quite variable. One pool above Hwy 22 in which cattle had been wallowing was extremely turbid and had a reddish scum of algae. Other pools contained black murky water, while some were clear and contained thick beds of submergent vegetation. A few very shallow pools had bright yellow-green algae growing on their bottoms.

Cyclopid copepods were the dominant zooplankters in most of the sampled pools. They decreased in relative importance in the lower stretches as calanoid copepods increased in abundance. Midge larvae (Diptera:Chironomidae) and oligochaetes were the dominant benthic organisms in all of the sampled pools (Figs. 19 and 20). The persistence of the pools and the diversity of organisms, even during this record dry summer, indicates a considerable capability to re-colonize the stream habitats when flow resumes.

A variety of organisms, in addition to those found in the samples, was observed to be closely associated with the pools and dry bed of the intermittent stream. Water striders (Hemiptera : Gerridae : Gerris) were observed on some of the small pools. Many crayfish holes were seen along the banks in dry sandy stretches, and freshly excavated wet mud was seen near the holes, indicating that the crayfish were active and that water was present beneath the channel. Armadillos had dug holes down into the stream channel in some dry stretches, and water was found in the bottom of the holes. On many of the upstream stretches, empty shells of unionid clams (Mollusca:Pelecypoda:Unionidae) were common. Some live molluscs were found on the exposed stream bed.

There is evidence of a considerable underflow in the Aquilla Creek substrate.

1. The pools were numerous and with generally good water quality in spite of the excessively dry summer.

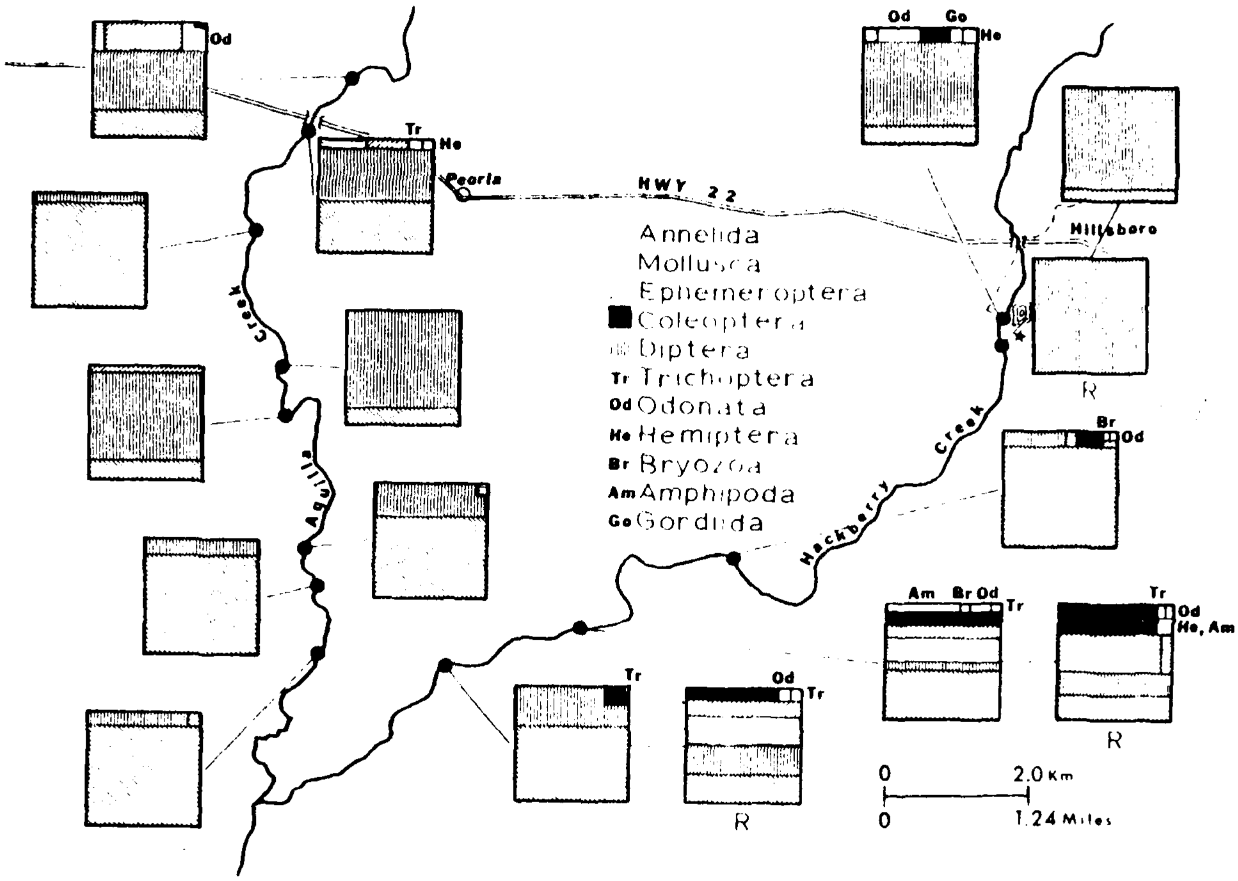


Figure 19. Percent abundance of major macroinvertebrate groups at selected locations along Aquilla and Hackberry creeks, August 20-21, 1981. An "R" beneath a square indicates a riffle location; all other squares represent pool locations. Solid lines connect locations on stream map to squares indicating precent abundance of benthos at those locations. A star indicates the location of the Hillsboro Sewage Treatment Facility.

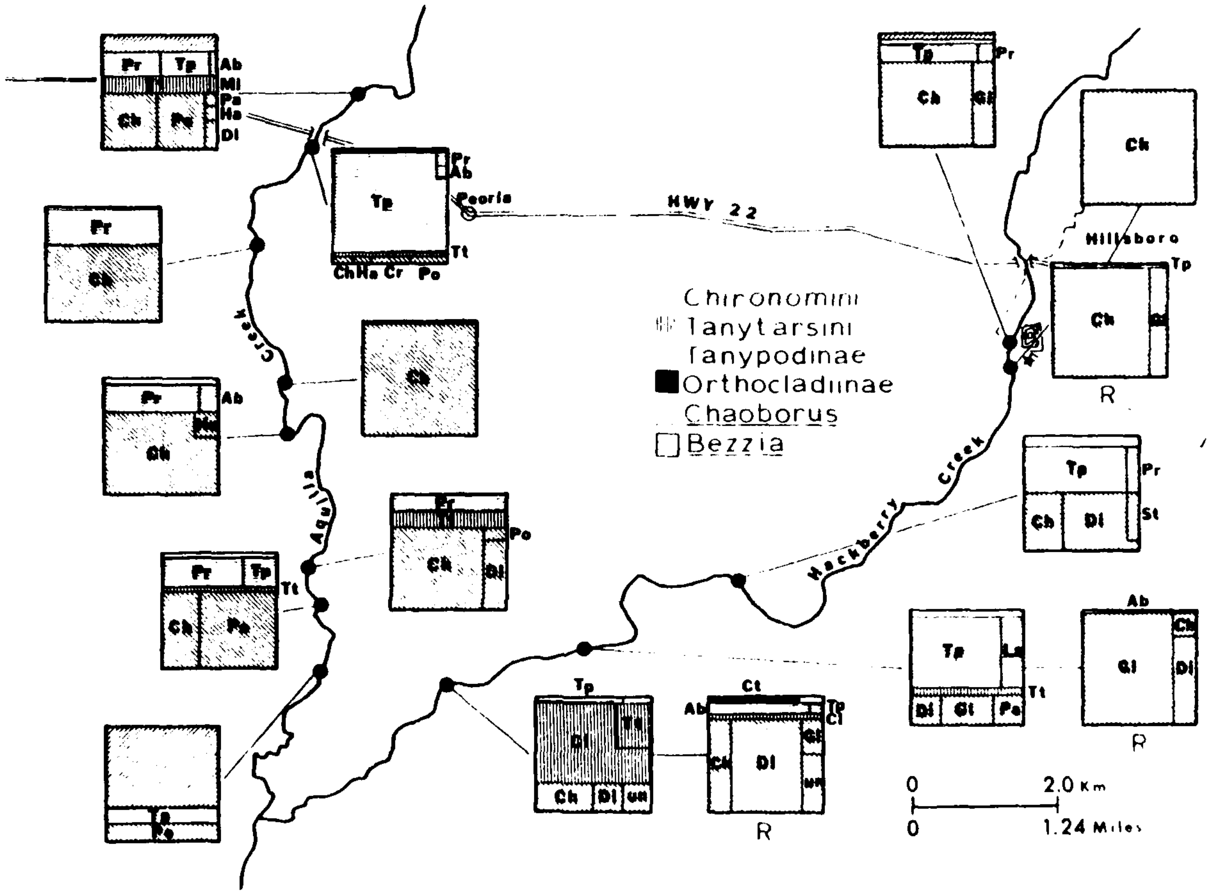


Figure 20. Percent abundance of genera of Diptera at selected locations along Aquilla and Hackberry creeks, August 20-21, 1981. Shaded areas indicate percentages of subgroups of Chironomidae, Culicidae (Chaoborus), and Heleidae (Bezzia). Ch, Chironomus; Po, Polypedilum; Di, Dicrotendipes; Ha, Harnischia; Pa, Parachironomus; Gl, Glyptotendipes; St, Stichochironimus; un., unidentified pupae; Tt, Tanytarsus; Mi, Micropsectra; Cl, Cladotanytarsus; Pr, Procladius; Tp, Tanypus; Ab, Ablabesmyia; La, Labrundinia; Ct, Cricotopus.

2. Crayfish holes and armadillo excavations had standing water.

3. Despite the fact that Hackberry Creek was permanent and Aquilla Creek had no surface flow, the pool at the dam reflected conductivities similar to Aquilla Creek readings rather than those of Hackberry Creek (Appendix M).

4. Despite the fact that dam construction had completely blocked the channel, there was a permanent flow in Aquilla Creek below the dam site (station E) and before the entrance of Cobb Creek.

At the first pool below the sewage plant inflow into Hackberry Creek, a pH of 9.4 was recorded (Appendix L) and a dense bloom of bluegreen algae (Microcystis sp.) reduced the transparency of the water to less than 2 inches (5 cm). The pH gradually decreased downstream, with the pH measuring 7.9 at the construction site of the dam below the confluence with Aquilla Creek. The conductivity of Hackberry Creek measured 2300 or 2400 micromhos at all sampling stations.

The zooplankton of upper Hackberry Creek was dominated by rotifers and cyclopid copepods. Calanoid copepods increased in importance at the lower sampling stations. Midge larvae and oligochaetes were the dominant benthic organisms in the pool areas, and were co-dominants in the riffles. Mayfly nymphs (Baetidae:Caenus), beetle larvae (Hydrophilidae:Berosus), snails (Physidae), and small clams (Sphaeridae) were also important benthic organisms in riffle areas, especially where filamentous algae was growing (Fig. 19). Very few species were found in the bottom samples collected just below the sewage plant inflow; however, many more taxa were collected from a pool just above the sewage plant and at the downstream access points.

Since dipterans were found in samples from all locations during the low water survey, the qualitative distribution of major dipteran groups was examined (Figure 20). Chironomids, especially genera of Chironomini and Tanypodinae, were important at most of the stations on Aquilla and Hackberry Creeks. The bloodworm Chironomus (Chironomini) and predatory midge larva Tanypus (Tanypodinae) were relatively important in several of the Aquilla Creek pools; Glyptotendipes and Dicrotendipes (both Chironomini) were important in many of the samples collected from Hackberry Creek. Chaoborus (Culcidae) was found in the uppermost sampled pools of both streams and at the lowermost sampled pool on Aquilla Creek. Bezzia (Heleidae) was a minor component of the dipteran fauna but was found at several locations on both streams.

Fish population samples were taken at 6 sites on the Aquilla Creek drainage during March, June, August, and December of 1980. Identical seining and electrofishing techniques were used each time except when reduced water flow neccessitated adaptation. During the low water period in August total samples were taken in isolated pools using repeated seining and rotenoning. The sampling procedures were designed to produce effective sampling of all habitat types present at each site.

Sampling produced a total of 28 taxa of fishes (Table 17). Sampling was consistent through time, producing 19, 20, 27, and 19 species in the quarterly samples, respectively. Site B, the upper Aquilla Creek site, produced only 13 species compared to 20 species at the Hackberry and downstream Aquilla creek sites. Cobb Creek sites were intermediate in diversity. The only species collected which had not previously been reported from the middle Brazos River drainage was the blackspotted topminnow which is easily confused with the

Table 17. Species of fish present at 6 sites on 3 creeks in the Aquilla Creek drainage area.

Species	Creek Site					
	Hackberry	Aquilla			Cobb	
	A	B	C	E	D	F
Longnose Gar			X	X		
Gizzard Shad	X	X	X	X	X	X
Carp	X	X	X	X	X	
Stoneroller					X	
Golden Shiner	X	X				
Red Shiner	X		X	X	X	X
Blacktail Shiner			X	X		
Shiner (*Notropis* sp.)	X					
Bullhead Minnow	X		X	X	X	X
River Carpsucker	X		X	X	X	X
Black Bullhead	X	X			X	X
Yellow Bullhead	X	X	X	X	X	X
Channel Catfish	X		X	X		X
Tadpole Madtom	X		X	X	X	X
Flathead Catfish			X	X		
Blackstripe Topminnow	X		X	X	X	X
Blackspotted Topminnow						X
Mosquitofish	X	X	X	X	X	X
Green Sunfish	X	X	X	X	X	X

Table 17. Continued.

Species	Creek Site					
	Hackberry	Aquilla			Cobb	
	A	B	C	E	D	F
Orange Spotted Sunfish	X	X	X	X	X	X
Bluegill Sunfish	X	X	X	X	X	X
Longear Sunfish	X	X	X	X	X	X
Redear Sunfish	X	X				
Spotted Bass			X			
Largemouth Bass	X	X	X	X		X
White Crappie	X	X	X	X		X
Dusky Darter			X			
Freshwater Drum				X		
Total 28	20	13	21	20	15	16

closely-related blackstriped topminnow. The blackspotted topminnow was collected only at 1 site by rotenone sampling. Five species comprised 85% of the catch: 2 cyprinids--red shiner and bullhead minnow; 2 centrarchids -- longear and green sunfish; and mosquito fish. In spite of their abundance at other sites, red shiners and bullhead minnows were not found at the upper Aquilla Creek site (B) in any samples, including the rotenone sampling.

Most fishes collected were small. Except for the 5 abundant species, numbers collected were insufficient to develop informative length-frequency distributions. Nevertheless, each species was represented by at least some small individuals, indicating that the stream was serving as a spawning or nursery area. Presence of adults of most species suggest that permanent populations occur in the streams; for example, age distributions of most sunfishes included individuals up to age III or IV, the normal longevity for the species. Large individuals were typically restricted to the deeper habitats at the downstream sites.

For those species with adequate numbers, length-frequency analysis through time indicated both growth and reproduction. Samples taken later in the year were characterized by modes at larger lengths, indicating growth during intervals between samples, and by the continual appearance of small fish, indicating reproduction and recruitment.

Length-weight relationships were developed for 4 species -- green and longear sunfish, red shiner, and bullhead minnow -- for those stations and dates which sample sizes were adequate (Appendix N). Extremes in regression coefficients frequently were associated with small sample sizes, but analysis of variance indicated that on any sampling date, significant variance in slope occurred among stations for each species. This result indicates that condition of fish of different sizes varied differentially among sites; that is, a site conducive to high condition of large fish was not necessarily conducive to high condition of small fish. Differences in length-weight relationships from one sampling date to another typically occurred, indicating the changing habitat conditions during the study.

The 6 sites can be reasonably grouped into 3 types based on fish community similarities. Sites A, C, and E (Hackberry and lower Aquilla Creek sites) had large numbers of species (20-21 each). Of 27 total species found at these sites, 16 occurred at each site. These 3 sites were characterized by long stretches of riffles and deep pools, thereby providing a diversity of habitats. Depth of both riffles and ponds increased from upstream to downstream, providing increased habitat for riverine species such as the blacktail shiner and large species such as longnose gar at the lower site.

The Cobb Creek sites (D and F) can be grouped based on lower diversity (15-16 species each), probably due to the smaller size and intermittent nature of the stream since these sites also contained a combination of pools and riffles. Of the 18 total species in Cobb Creek, 13 were collected at both sites. In addition to a lower total number of species, Cobb Creek provided habitat for only subadults of several large species such as gizzard shad, carp, carpsuckers, channel catfish, and largemouth bass.

The upstream Aquilla Creek site (B) was uncharacteristically low in diversity (13 species) and number (46% of the total catch). This site lacked the habitat diversity of the other sites. It had no pronounced pool-rifle interspersion, but rather was a uniform width and depth, resulting in an organic bottom which may have altered water quality. Four otherwise ubiquitous species -- red shiner, bullhead minnow, river carpsucker, and blackstripe topminnow were not collected at this site, even when routine sampling was supplemented with rotenone sampling.

Fish communities in the study area appeared to vary in relation to stream size, habitat diversity, and water quality. Intermittent Cobb Creek probably is somewhat more limited as a nursery area than the larger Aquilla and Hackberry Creeks. Except for the Aquilla site B, the stream showed characteristic increases in diversity from headwaters to downstream areas, with the inclusion of larger individuals in downstream pools and riverine species in downstream riffles.

Overview

The project study area in Hill County, Texas, lies in the middle of the Brazos River Basin. It is characterized by gently rolling hills bisected by Aquilla, Little Aquilla, and Hackberry Creeks. The project lands are located within the Blackland Prairie and Eastern Cross Timbers Land Resource Areas in north-central Texas.

Blackland Prairie plant communities were developed on alkaline black clay soils. Prior to extensive cultivation, the dominant herbaceous vegetation was little bluestem. The Blackland Prairie portion of the area has been converted to cropland, primarily grain sorghum and cotton. In 1972, over 46% of the project lands were cultivated. In 1982, the broad study area included over 51% cropland.

Travelling west on Highway 22 from Hillsboro, Texas, the almost flat croplands of the Blackland Prairie region abruptly terminate near Peoria and are replaced by rolling hills and pastures of the Eastern Cross Timbers. The Eastern Cross Timbers, formerly a mixture of oak woodlands and prairie grasses, such as little bluestem developed on slightly acidic sandy loam soils. Over-grazing, farming, and fire suppression have resulted in the thicketization of the woodlands through encroachment of brush species such as cedar elm, scrub oaks, and green-brier. Grazing, the dominant land use of the Eastern Cross Timbers, has resulted in areas of improved pasture intermixed with thicketized woodlands and overgrown oldfields.

In general, avian populations on project lands were representative of north-central Texas. Open habitats were more productive for diurnal raptors, whereas owls reached their highest diversity in forest habitats. Both owls and diurnal raptors achieved highest abundance in winter. Gamebird routes produced highest call-counts in open habitats such as cultivated Blackland Prairie sites and shrub parkland regions of the Eastern Cross Timbers. An analysis of key species indicated greatest species diversity in riparian woodlands and least species diversity in pasture habitats. With the exception of the wood duck, which nests on the area, waterfowl were most abundant in winter.

Cotton rats and Peromyscus sp. comprised over 82% of the small mammals captured during the study. Cotton rats were most plentiful at sites with tall herbaceous cover and Peromyscus sp. predominated in areas of sparce vegetation. An analysis of small mammal community composition indicated that there was less variation attributable to habitat type than due to seasonal differences within a habitat type. Parkland/woodlands and pastures were the most significant habitat types in terms of trap success and individual species separation. Large mammal sightings, dominanted by eastern cottontails, included observations of bobcats and a mountain lion.

Physical, chemical, and biological characteristics of Aquilla and Hackberry creeks reflect, in large part, the effects of base water source flow and watershed characteristics. Hackberry Creek, which maintains a continuous

surface flow generated by effluent from the Hillsboro sewage treatment lagoon, has a high nutrient load and more pronounced oxygen deficits. Hackberry Creek and sections of Aquilla Creek below the dam site produced the largest number of fish species. In general, fish species diversity increased in Hackberry Creek from headwaters to downstream areas.

Surface flow in Aquilla Creek above the dam site was intermittent for most of the year. No pronounced pool-riffle interspersion was present. Many pools with organic bottoms were found at sites behind fallen trees, or in 1 case, behind a beaver dam. Evidence of considerable underflow in Aquilla Creek substrate was found. Fish species diversity was uncharacteristically low. Fish communities on the project area including Cobb Creek appeared to vary in relation to stream size, habitat diversity, and water quality.

CHANGES ASSOCIATED WITH CONSTRUCTION ACTIVITIES AND IMPOUNDMENT

Comparison with EIS Projections

Compared to the Environmental Impact Statement (EIS) for Aquilla Lake (U.S. Corps of Engineers 1976), the data presented in the EIS concerning percent coverage of cropland, 63.7, (7520 ac = 3,044 ha) was high; pre-impoundment data suggested cropland comprised 46.8% (4,848.1 ha). Our estimate of pasture, 27.4%, (3,235 ac = 1,309.7 ha) was high compared to 1976 pre-impoundment data of 14.2% (1,467.9 ac = 594.3 ha). Similarly, the EIS underestimated woodland, 8.8%, (1,045 ac = 423.1 ha) while data from this study suggested 39.8% (4,047.1 ac = 1,638.5 ha).

The EIS mentions that several bottomland hardwoods, ferns, and mosses should reestablish on the lakeshore after an interim period. Vegetation associated with bottomland habitat types are present because of proper environmental conditions. At least 55% (364.8 ac = 147.7 ha), of bottomland habitat types will be lost due to inundation. Water alone will not make up for the lack of proper bottomland soils as aluded to in the EIS. No bottomland hardwoods or ferns will reestablish naturally along the lakeshore, given the life span of the lake. Reforestation is the only method of reestablishing bottomland hardwoods once the seed source has been greatly decreased. Lack of proper soil type will greatly affect the survivorship of any bottomland hardwood planted along the lakeshore. Following impoundment and stabilization of the lake, lake shore vegetation will change depending on the tolerance of vegetation to periodic flooding and increase in soil moisture.

The seed source of established species is very large. It is unlikely that species new to the area will become established on disturbed sites as mentioned in the EIS. Density of weed species found on the area will increase on disturbed sites. This is evidenced by ongoing old field succession on croplands.

The absence of flooding in the flood plain and riparian forest below the dam (T4-2) could cause changes in species composition and abundance. These changes should be evident in follow-up studies.

Over the 18 month study period approximately 300 plant species were collected, 224 of which have been identified (Appendix O). All woody species and 90% of the herbaceous species reported in the EIS were identified on the project area.

Appendix P compares data collected during this study with the bird list

presented by U.S. Corps of Engineers (1976). The U.S. Corps of Engineers (1976) listed 262 species, 78 of which were unobserved during this study. Many of the unobserved birds were species of open water and shorelines. Lack of significant open water areas and shorelines along transects and in the project area accounted for the differences. The absence of terrestrial species listed for the study area is more difficult to explain. Twenty-eight terrestrial species listed by the U.S. Corps of Engineers (1976) were not seen during this study. Of these, pileated woodpecker, northern parula warbler, yellow-throated warbler, and scarlet tanager were listed as nesting in the area. None of these species were observed during this study. While it is possible that some migrants were missed, it is unlikely any of these species nested on the study area in 1980.

During 1980-81, 201 species were observed on the study area (Appendix P). Eighteen species were not listed on the 1976 list. Of these, 5 are confirmed breeders on the area: green heron, white-tailed kite, turkey, ladder-backed woodpecker, and acadian flycatcher. Substantial differences in abundance of species were noted in some cases. For example, 11 nesting species listed in 1976 were recorded as migrants in 1980-81, but no evidence of nesting activity was observed.

Impoundment impacts on mammals will be limited to those species directly associated with bottomland and riparian habitat types. The EIS mentions 14 species which will be negatively affected. Of these species, raccoon, beaver, and swamp rabbit are primarily riparian forms. The only beaver and deer sightings were on Aquilla Creek north of transect 3. This area will not be greatly affected by impoundment. Several species mentioned in the EIS, flying squirrel, mink, and gray fox were not observed on the project area. The remaining species mentioned, opossum, armadillo, fox squirrel, white-footed mouse, Florida wood rat, and eastern cottontail are ubiquitous in habitat needs and will not be greatly affected by impoundment. Appendix Q provides a checklist of mammals identified or that could occur on the project study area.

Two felids, bobcat and mountain lion, were observed on the Hackberry Creek portion of the project. The bobcat was seen near Hillsboro in cropland adjacent to riparian habitat. A mountain lion was observed crossing the county road bridge on Jack's Branch, a tributary of Hackberry Creek. Unconfirmed reports of mountain lions in nearby McClennan County and confirmed reports in Eastland County (Jose Cano, Texas Parks and Wildlife Department, pers. comm.) substantiate the likely appearance of mountain lions in the Hill County area. Due to the sparcity of cover in adjacent riparian areas, it is suspected that use of these areas may represent elongation of existing home ranges or travel and dispersal routes. Aquilla Lake impoundment will block travel routes, forcing these cats to alter their home ranges.

The Texas Parks and Wildlife Department released 50 white-tailed deer approximately 10 mi (6.2 km) south of the village of Aquilla in January 1983 (Charles Winckler, pers. comm.). Survivors of the transport effort may populate portions of the project study area. Doe groups will move from the transplant site slowly. Certain bucks in the population, which are prone to move over large areas, may appear on project lands sooner.

A list of 20 amphibians and 55 reptiles, whose range includes the Aquilla Creek Basin, was presented in the EIS. Our study of the Aquilla Project fee lands produced 8 amphibians and 22 reptiles, or 40% of those mentioned in the EIS (Appendix R).

Loss of riparian habitat will greatly decrease those species dependent on flowing waters, such as salamanders and newts. More mobile species, turtles, frogs, and snakes will be less affected by inundation. As mentioned in the

EIS, several species of turtles and snakes will benefit from impoundment. Softshell turtles were mentioned as being adversely affected. Extensive trapping for turtles in ponds and lakes of south Texas has shown that softshell turtles thrive in these palustrine habitats. However, too many turtles can be a detriment to ponds and lakes, in terms of their predatory effects on other species. Impoundment should have minimal impact on lizards. Numerous skinks which will be affected by impoundment were mentioned in the EIS. Many of these skinks have a broad range of habitat preference, and were found throughout the project area. Two skinks, broad-headed and ground, were found on upland sites away from the impoundment zone. Snakes should not be seriously threatened by inundation.

If the impoundment process occurs over a long period of time, many affected species will have time to relocate into new favorable habitats around the lake, and/or upstream in unaltered riparian and bottomland habitats. Long term survivorship of relocated animals will depend on availability of specific resources and the population density of resident forms in the new habitat. If however, the lake fills rapidly, small mammals and many amphibians and reptiles will be lost. The most severe effect of lake construction on amphibians and reptiles was the clearing of timber and brush for the conservation pool. This mechanical alteration of habitat greatly reduced available cover for all species, increasing their vulnerability to predation.

In the initial environmental impact study of the Aquilla Creek watershed, U.S. Corps of Engineers (1976) reported in the survey of the zoological resources that large populations of <u>Physa virgata</u> (Mollusca:Physidae), <u>Chaoborus</u> (Diptera:Culicidae), and <u>Tendipes</u> (Dipteria:Chironomidae) were found in areas of stream where deep deposits of silt occurred beneath standing water. The taxon <u>Tendipes</u> is synonymous with the taxon <u>Chironomus</u> reported in our study. The latter is the more widely accepted generic name (Mason, 1973). Our findings are similar to those of U.S. Corps of Engineers (1976) in that <u>Chaoborus</u> and <u>Chironomus</u> were again found in abundance in stagnant pools.

U.S. Corps of Engineers (1976) found large numbers of <u>Sphaerium transversum</u> (Mollusca:Sphaeridae) in gravel banks at a sampling site on Aquilla Creek, and thought that silt limited their occurrence elsewhere in the watershed. We found this taxon at all of the quarterly sampling stations on Aquilla and Hackberry Creeks, and on many dates it occurred at high densities in riffles. We did not find most of the 14 mollusc species found by U.S. Corps of Engineers (1976) but we found four additional species, <u>Strophitus undulatus</u>, <u>Sphaerium partumeium</u>, <u>Eupera cubensis</u>, and <u>Corbicula manilensis</u>.

The total densities of benthic macroinvertebrates reported by U.S. Corps of Engineers (1976) are much lower than those we report. Some differences may be attributable to different collection efficiencies, but this is difficult to evaluate since they only report on their method of separation, and do not describe their method of collecting benthic samples. U.S. Corps of Engineers (1976) determined that the diversity of invertebrates was low in their collections because many animals were not tolerant of the warm summer temperatures. Our findings contradict this speculation. Our quarterly sampling indicates that the greatest variety of taxa occurred during the late summer. The Corps reported that their collections were taken during a period with below normal rainfall during and preceeding the study, but discharge was higher (during their sampling period of June, July 2nd, August) in 1972 than in 1980.

Our collections of zooplankton taken during the low water survey indicate a greater variety of taxa than was found by U.S. Corps of Engineers (1976). We found 10 more species of Cladocera, and a preponderance of calanoid

copepods at the dammed stream sections near the construction site. Like U.S. Corps of Engineers (1976), however, we found that cyclopid copepods were the dominant zooplankters at other locations.

The differences between the 2 studies are not very great, and there is no evidence of a major change in the aquatic ecosystem since the 1972 study (U.S. Corps of Engineers 1976). No fish species were collected which were not previously reported from the middle Brazos River drainage (U.S. Corps of Engineers 1976).

Habitat/Land Use Changes

Minimal land use changes on the broad study area could be associated with construction and impoundment of Aquilla Lake. Although our study began after construction had been initiated, a review of aerial photography in 1972, 1979 and 1982 found little change in land use or habitat alteration. The most significant habitat alterations on the project area between 1979 and 1982 were increases in disturbed areas, attributable to clearing (Table 18), and an increase in old field habitat related to plant succession on former cropland habitats.

The most significant loses of habitat types resulting from clearing were in old fields (29.6%), cropland (14.4%), and riparian woodlands (10.4%), or a total of 35.8% (1,173.7 ac = 475.2 ha) of the conservation pool (3,280 ac = 1,327.9 ha).

Estimated habitat losses due to impoundment are given in Table 19. The most significant losses resulting from impoundment will be cropland and parkland/woodland habitats, totaling 43.9% (1,439.6 ac = 582.6 ha) of the approximately 3,280 ac (1,327.9 ha) lake. A more complete breakdown of habitat types lost due to clearing and/or impoundment is given in Appendices T and U. Major habitat types are broken down into subcategories by dominate overstory species. Significance of habitat losses associated with construction activities and impoundment will be discussed in terms of terrestrial animal resources.

Terrestial Wildlife Resources

Based on estimated habitat losses due to clearing and impoundment (Table 20), and weighted density values for key avian species taken from transect census by habitat, potential displacements resulting from combined construction and impoundment activities were determined (Table 21). The most significant losses resulting from final impoundment on Parkland/Woodland habitat among nongame species would be seed-eating cardinals, Harris' sparrows and Carolina chickadees, all of which are permanent residents on the area. Within the riparian woodland habitat, significant displacements among cardinals, Harris' sparrows and the winter resident white-throated sparrow, are likely to occur. The most significant cropland species present were migratory blackbirds. Eastern meadowlarks and blackbirds would be lost in greatest numbers in pasture habitats. Pasture habitats included the largest number of species of grassland or open county birds.

Diurnal raptors were most often observed in open habitats, especially during time area counts. Hawk density values (Table 21) generated from transects suggest that pasture and parkland/woodland habitat impoundment would result in significant displacement. Woodlands, both upland and riparian, are important for roosting and nesting sites for diurnal raptors. In the open

Table 18. Estimated habitat types lost due to clearing, 1982.

Habitat Type	Acres	Hectares	% of Habitat types Cleared	% of Fee Lands Lost
Forest	378.5	153.2	17.5	3.7
Woodland	178.6	72.3	8.3	1.7
Parkland	155.7	63.0	7.2	1.5
Shrub Parkland	37.1	15.0	1.7	0.4
Savannah	7.1	2.9	0.3	0.1
Shrub	209.0	84.6	9.7	2.0
Parkland	56.8	23.0	2.6	0.5
Savannah	152.2	61.6	7.0	1.5
Developed	1,348.2	545.9	62.4	13.2
Cropland	310.5	125.7	14.4	3.0
Pasture	184.0	74.5	8.5	1.8
Oldfield	638.9	258.7	29.6	6.3
Riparian				
Woodland	224.3	90.8	10.4	2.2

Total lost due to clearing = 2,160 ac.

Table 19. Estimated habitat types lost due to impoundment (exclusive of that lost due to clearing), 1982.

Habitat Type	Acres	Hectares	% of Habitat types lost	% of Fee lands lost
Forest	350.2	141.8	29.3	3.4
Woodland	232.2	94.0	19.4	2.3
Parkland	59.9	24.2	5.0	0.6
Shrub Parkland	24.7	10.0	2.0	0.2
Savannah	33.4	13.5	2.8	0.3
Shrub	103.9	42.1	8.7	1.0
Shrub Parkland	11.5	4.7	0.9	0.1
Savannah	92.4	37.4	7.7	0.9
Developed	601.7	243.6	50.3	5.9
Cropland	290.7	117.7	24.3	2.8
Pasture	269.9	109.3	22.5	2.6
Oldfield	41.1	16.6	3.4	0.4
Riparian				
Woodland	140.5	55.9	11.7	1.4

Total project area = 10,213 ac.
Total impoundment = 1,196.3 ac. (exclusive of that lost due to clearing).

Table 20. Total estimated habitat lost due to clearing and impoundment, 1982.

Habitat Type	% Fee Lands Lost	% Habitat Types Lost	Acres
FOREST	(7.1)	(21.7)	(728.7)
Woodland	**4.0**	**12.2**	**410.8**
Mesquite	0.8	2.5	85.4
Oak	0.4	1.4	46.7
Cedar elm	2.2	6.7	226.5
Mesquite/cedar elm	0.1	0.3	9.9
Mesquite/oak	0.2	0.5	17.7
Cedar elm/oak	0.2	0.5	17.0
Cedar elm/pecan	2.1	0.2	7.5
Parkland	**2.1**	**6.4**	**215.6**
Cedar elm	0.7	2.2	72.8
Oak	0.1	0.2	6.0
Pecan	0.6	1.8	59.3
Mesquite/cedar elm	0.7	2.2	74.2
Cedar elm/pecan	<0.1	0.1	3.3
Shrub Parkland	**0.6**	**1.8**	**61.8**
Cedar elm	0.1	0.4	13.6
Oak	<0.1	0.1	2.5
Mesquite/cedar elm	0.4	1.4	45.7
Savannah	**0.4**	**1.2**	**40.5**
Mesquite	0.1	0.2	7.1
Oak	<0.1	0.1	4.2
Pecan	0.3	0.9	29.1
SHRUB/SCRUB	(3.1)	(9.3)	(312.9)
Shrub Parkland	**0.7**	**2.0**	**68.3**
Mesquite	0.7	2.0	68.3
Savannah	**2.4**	**7.3**	**244.6**
Mesquite	2.3	6.9	231.6
Mesquite/cedar elm	0.1	0.4	13.0
DEVELOPED	(19.1)	(58.1)	(1949.9)
Cropland	5.9	17.9	601.2
Pasture	4.4	13.5	453.9
Oldfield	6.7	20.3	680.0
Disturbed	2.1	6.4	214.8
RIPARIAN	(3.6)	(10.9)	(364.8)
Woodland	3.6	10.9	364.8

Total fee lands lost to clearing and impoundment = 3,356.3 ac
Total fee lands in project = 10,213 ac

Table 21. Potential key avian species displacement due to impoundment. Values represent total number displaced from estimated habitat losses resulting from clearing and impoundment*.

Species	Parkland/Woodland	Riparian Woodland	Cropland	Pasture
vultures	5	2	0	9
hawks	24	1	1	66
owls	0	1	0	0
Bobwhite	41	10	1	8
Mourning Dove	93	5	0	28
American Crow	82	12	0	17
Cardinal	397	35	0	24
blackbirds			45	351
Eastern Meadowlark			15	947
Savannah Sparrow			12	111
Vesper Sparrow			4	43
Loggerhead shrike			0	9
swallows			3	4
Killdeer			1	
Scissor-tailed Flycatcher				6
Cattle Egret				8
Upland Sandpiper				4
Song Sparrow				1
Dickcissel			7	
Downy Woodpecker	4	3		
Yellow-billed Cuckoo	3	3		
Carolina Chickadee	116	13		

Table 21. Continued.

Species	Parkland/Woodland	Riparian Woodland	Cropland	Pasture
Blue Jay	51	3		
Tufted Titmouse	22	3		
wrens	38	5		
Harris' Sparrow	104	28		
White-throated Sparrow	6	43		
Yellow-rumped Warbler		7		
Brown-headed Cowbird	48			
Indigo Bunting	16			

country the migratory American kestrel would be most affected. Data from transects and from nocturnal counts suggest that significant displacement of owls from forested habitats would occur.

Mourning dove displacement would be greatest in parkland/woodland and riparian woodland habitats. Although doves were observed foraging in open habitats, woodland sites represent significant nesting and roosting locations. The most significant habitat losses for bobwhite would be the riparian woodlands which provide important nesting and cover requirements. Although shorebirds, waterfowl, and other wetland species are not included as key species for the area, it can be anticipated that their numbers will be increased after final impoundment.

Because of the similarities of the mammalian communities among habitats, small mammal losses due to inundation will be in proportion to the percentage of habitat types lost (Table 20). Further, because of the overwhelming representation of cotton rats and Peromyscus sp. in the mammalian fauna these forms will be most drastically affected by impoundment. Although, Florida wood rats, least shrew, and plains harvest mice were captured primarily in parkland/woodland habitats, small sample size precludes definitive statements on the importance of loss. Of the larger mammal species observed during field work, the loss of riparian habitat due to impoundment will result in displacement of the following: beaver, swamp rabbit, red fox, skunks, bobcat and raccoon. Monitoring of relative abundance of large mammals should be continued on project lands with special emphasis on introductions of white-tailed deer.

Aquatic Resources

When full and operating the reservoir will have flooded all the habitat affected by construction activities, except for the new channel connecting the outlet to Aquilla Creek and a small section of the old channel which will be bypassed.

Upstream at conservation pool level small sections of stream will be inundated. The littoral zone of the lake will provide several orders of magnitude more year-round aquatic habitat than that lost by flooding. All major groups of organisms found in the flooded stream will be found in the littoral zone of the lake, though species composition will change. The productivity of the deep water benthos will depend upon hypolimnetic oxygen values. It is expected that the hypolimnion will be anaerobic for part of the summer, thus limiting productivity of this area. When benthic production is coupled with new planktonic populations, the lake will provide aquatic productivity several orders of magnitude greater than that lost by inundation of the stream sections.

Downstream from the lake, the limnological effects of the impoundment of Aquilla Creek are totally dependent upon the nature and scheduling of water release. If release is completely terminated at any time during the year drastic changes in biota will occur in the creek. If minimum levels of discharge are maintained the discharge should have less violent swings than before construction and downstream productivity could increase.

Marked changes in the fish community can be expected following impoundment. The species assemblage occurring in the upsteam reaches will likely develop into a diverse lake fish community. Most species collected are capable of adapting to lentic conditions and most will persist in Aquilla

Lake. However, changes in relative abundance will occur as centrarchids (sunfishes), ictalurids (catfishes), and cluperds (shad) become dominant.

Downstream sites on Aquilla Creek will be influenced by lake discharge. Community composition will be determined by lake release regimes, particularly current velocities and annual release patterns (seasonal flow). Fish species composition will change little, but relative abundance will change if flow differs markedly from natural conditions. Cobb Creek should change little unless alterations in land use occur. If Cobb Creek remains in its current condition, it will provide a basis for comparison with lower Aquilla Creek, allowing determination of direct and indirect effects of lake release.

Overview

During the period of this study, 1979-1982, no significant changes in land use patterns on the broad study area could be attributable to activities associated with construction and impoundment. Clearing and associated construction activities within the conservation pool has resulted in the loss of 29.6% oldfield, 14.4% cropland, and 10.4% riparian habitats. After impoundment has been completed significant losses of pecan parkland , riparian woodland and mesquite savannah habitats will occur. Wildlife dependent on these riparian habitats will be severely affected by impoundment. Losses of owl and diurnal raptor nesting and foraging habitat will be considerable. Bottomland habitats also represent important nesting and/or cover sites for both bobwhite and mourning dove. Small mammal losses, primarily rodents, will be proportional to the amount of habitat lost due to clearing and impoundment. Larger more mobile mammals will be able to relocate into new habitats after impoundment. Long-term survivorship of relocated animals will depend on availability of specific resources and density of resident populations in the new habitat.

After impoundment all watercourses, except the most upstream portions of Aquilla and Hackberry creeks, will be inundated. It is likely that all major groups of organisms found in the flooded streams will be found in the littoral zone of the lake, though species composition will change. Downstream from the dam site, limnological and biological effects of impoundment will be totally dependent on the nature and scheduling of water release. Sunfishes, catfishes, and shad can be expected to form the dominant groups of fishes in the lake community. Downstream, fish species composition will change little, but relative abundance will be altered if flow changes from natural conditions.

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Appendix A. Hill County weather data for 1979-80.

	1979		1980	
	Temp.	Precip.	Temp.	Precip.
Month	°F (°C)	in (cm)	°F (°C)	in (cm)
January	36.9 (2.7)	2.6 (6.6)	46.8 (8.2)	2.9 (7.5)
February	45.8 (7.6)	2.7 (6.8)	48.3 (9.0)	1.0 (2.6)
March	58.8 (14.9)	5.8 (14.6)	55.3 (12.9)	2.5 (6.3)
April	65.0 (18.3)	3.9 (10.0)	63.2 (17.3)	4.6 (11.8)
May	69.2 (20.7)	8.8 (22.4)	73.0 (22.8)	5.4 (13.7)
June	79.1 (26.2)	3.4 (8.5)	83.3 (28.5)	0.4 (0.9)
July	82.7 (28.2)	1.0 (2.4)	87.1 (30.6)	0.1 (0.3)
August	81.3 (27.4)	4.0 (10.1)	86.0 (30.0)	1.6 (4.0)
September	75.2 (24.0)	1.9 (4.7)	79.7 (26.5)	4.4 (11.2)
October	70.3 (21.3)	3.8 (9.7)	65.4 (18.6)	0.0 (0.0)
November	52.6 (11.4)	0.3 (0.8)	55.2 (12.9)	1.9 (4.7)
December	50.3 (10.2)	3.8 (9.7)	50.8 (10.4)	2.6 (6.7)
Annual	63.9 (17.7)	41.9 (106.4)	66.2 (19.0)	27.4 (69.6)
Departure from Normal	-2.0 (-3.6)	+7.4 (+18.8)	+0.3 (+0.5)	-7.0 (-17.8)

AD-A144 988 AQUILLA LAKE BRAZOS RIVER BASIN TEXAS PRE-IMPOUNDMENT ENVIRONMENTAL STUDY..(U) ARMY ENGINEER DISTRICT FORT WORTH TX R D SLACK ET AL. JUN 83 2/3

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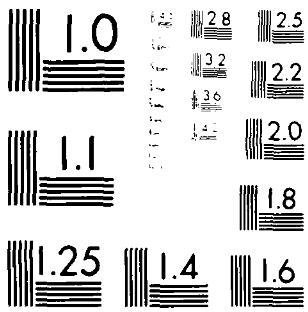


MICROCOPY RESOLUTION TEST CHART

APPENDIX B. Habitat type classification/identificaton code.

System	Class	Subclass modifiers
P - palustrine	EM - emergent vegetation	Water regime
R - riverine	1. persistent	A - temporary
1. perennial	2. nonpersistent	B - seasonal
2. intermittent	TC - tree covered (broad-leaved deciduous)	C - permanent
L - lacustrine	OW - open water	D - intermittently flooded
U - upland	SS - shrub (broad-leaved deciduous)	H - dikes or dams
B - bottomland	DV - developed	X - excavated pond
	1. urban/residential/commercial or industrial	Z - drainage ditch
	2. agricultural	Forest/shrub regime
	3. unvegetated land/spoils/dumps	E - cedar elm
	GR - grassland (native)	M - mesquite
		P - pecan
		Q - oak
		W - willow
		Additional modifiers
		a - woodland
		b - parkland
		c - shrub parkland
		d - cropland
		e - improved pasture
		f - oldfield
		g - savannah
		h - orchard
		i - forest (riparian)

Appendix C. Number and extent of pools observed in low water survey of Aquilla Creek August 20, 1980.

Section	1	2	3	4	5
Location in River miles (river km)	0.8 mi (1.3 km) above HWY 22 to 0.4 mi (0.6 km) below	1.05 to 1.86 mi (1.7 to 3.0 km) below HWY 22	2.67 to 3.97 mi (4.3 to 6.4 km) below HWY 22	3.6 to 2.5 mi (5.8–4.0 km) below confluence with Hackberry creek	2.2 to 1.5 mi (3.5 to 2.5 km) above confluence with Hackberry creek
Number of Large Pools <98 ft (<30 m)	2	0	5	1	3
Total Length feet (m)	(238) 780.8	(0) 0	(500) 1,640.4	(95) 311.7	(980) 3,215.2
Number of Medium-sized Pools 16.4–98.4 ft (5–30 m)	9	0	10	11	0
Total Length feet (m)	(158) 518.4	(0) 0	(175) 574.1	(192) 629.9	(0) 0
Number of Small Pools >16.4 ft. (>5 m)	6	2	18	9	0
Total Length feet (m)	(15) 49.2	(5) 16.4	(45) 72.2	(22) 0	(0)

Appendix C. Continued.

Section	1	2	3	4	5
Total Length of Pools feet (m)	(411) 1,348.4	(5) 16.4	(720) 2,362.2	(390) 1,013.8	(980) 3,215.2
Total Length of Section feet (m)	(1846) 6,056.4	(1385) 4,543.9	(2154) 7,066.9	(1846) 6,056.4	(985) 3,231.6
% of Stream-bed with water	22%	0.4%	33%	17%	99%

Appendix D. Average densities/ac (density/ha) for each major overstory, understory, and shrub species (1980-81).

Grid	Growth Form*	Species	Average Density/ha	Average Density/ac
T 1-1	S	Prosopis glandulosa	2,141.4	866.9
T 1-2	O	Ulmus crassifolia	98.7	39.9
		Prosopis glandulosa	224.9	91.0
		Quercus stellata	15.2	6.1
		Quercus marilandica	8.6	3.5
	U	Ulmus crassifolia	350.0	141.7
		Prosopis glandulosa	244.5	99.0
		Celtis reticulata	44.8	18.1
		Quercus stellata	31.0	12.5
		Zanthoxylum clava-herculis	52.4	21.2
	S	Smilax bona-nox	413.4	167.4
		Ulmus crassifolia	351.3	142.2
		Prosopis glandulosa	70.6	28.6
		Celtis reticulata	48.5	19.6
		Quercus stellata	126.2	51.1
		Zanthoxylum clava-herculis	83.7	33.9
		Optuntia leptocaulis	588.4	238.2
T 1-3	S	Prosopis glandulosa	269.4	109.1
		Bumelia lanuginosa	62.4	25.2
		Celtis reticulata	17.8	7.2
T 1-5	O	Maclura pomifera	26.6	10.8
		Ulmus crassifolia	173.6	70.3
		Celtis laevigata	6.6	2.7

Appendix D. Continued.

Grid	Growth Form*	Species	Average Density/ha	Average Density/ac
	U	Maclura pomifera	101.8	41.2
		Crataegus sp.	160.3	64.9
		Ulmus crassifolia	321.2	130.0
		Fraxinus texensis	53.3	21.6
		Bumelia lanuginosa	87.9	35.6
	S	Symphoricarpos orbiculatus	5,009.7	2,028.2
		Forestiera pubescens	1,533.0	620.6
		Celtis laevigata	884.2	358.0
		Smilax bona-nox	1,065.9	431.5
T 1-6	O	Prosopis glandulosa	34.1	13.8
		Ulmu crassifolia	267.7	108.4
		Celtis laevigata	18.8	7.6
		Quercus stellata	51.9	21.0
	U	Celtis laevigata	50.0	20.2
		Ulmus crassifolia	337.7	136.7
		Gleditisa triacanthos	100.7	40.8
		Bumelia lanuginosa	95.4	38.6
		Prosopis glandulosa	39.5	16.0
		Crataegus sp.	136.1	55.1
		Juniperus virginiana	30.5	12.3
		Quercus shumardii	60.0	24.3
T 1-6	S	Ulmus crassifolia	545.2	220.7
		Forestiera pubescens	1,842.9	746.1

Appendix D. Continued.

Grid	Growth Form*	Species	Average Density/ha	Average Density/ac
		Symphoricarpos orbiculatus	2,293.7	928.6
		Crataegus sp.	178.6	72.3
		Smilax bona-nox	219.8	89.0
		Bumelia lanugiosa	378.4	153.2
T 2-2	O	Ulmus crassifolia	152.9	61.9
		Fraxinus texensis	21.1	8.5
		Celtis laevigata	16.5	6.7
		Maclura pomifera	5.1	2.1
	U	Sapindus drummondii	157.6	63.8
		Celtis laevigata	77.6	31.4
		Ulmus crassifolia	103.7	42.0
		Fraxinus texensis	39.0	15.8
		Morus rubra	10.6	4.3
		Maclura pomifera	21.7	8.8
	S	Sapindus drummondii	81.0	32.8
		Symphoricarpos orbiculatus	114.8	46.5
		Celtis laevigata	43.0	17.4
		Smilax bona-nox	241.0	97.6
		Bumelia lanuginosa	45.9	18.6
T 2-3	S	Prosopis glandulosa	34.1	13.8
		Bumelia lanuginosa	1.8	0.7
		Gleditsia triacanthos	3.0	1.2
		Maclura pomifera	1.7	0.7

Appendix D. Continued.

Grid	Growth Form*	Species	Average Density/ha	Average Density/ac
T 3-1	S	Prosopis glandulosa	27.5	11.1
		Quercus stellata	3.6	1.4
		Opuntia phaeacantha	7.7	3.1
		Smilax bona-nox	1.7	0.7
		Juniperus virginiana	5.0	2.0
		Gleditsia triancanthos	1.7	0.7
		Zanthoxylum clava-herculis	3.7	1.4
T 3-2	O	Carya illinoinensis	37.7	15.3
		Maclura pomifera	1.6	0.6
		Fraxinus texensis	2.1	0.8
	U	Carya illinoiensis	6.1	2.5
		Maclura pomifera	5.4	2.2
		Cornus drummondii	2.3	0.9
		Ilex decidua	8.6	3.5
		Ulmus crassifolia	7.0	2.8
		Gleditsia triacanthos	2.5	1.0
		Celtis laevigata	6.1	2.5
		Bumelia lanuginosa	2.2	0.9
	S	Smilax bona-nox	23,884.7	9,669.9
		Ulmus crassifolia	1,086.4	439.8
		Symphoricarpos orbiculatus	1,112.0	450.2
T 4-2	O	Quercus virginiana	63.1	25.5
		Ulmus crassifolia	344.0	139.3
		Fraxinus texensis	47.3	19.1

Appendix D. Continued.

Grid	Growth Form*	Species	Average Density/ha	Average Density/ac
		Sapindus drummondii	39.4	16.0
T 4-2	U	Fraxinus texensis	1,408.1	570.0
		Ulmus crassifolia	557.4	225.7
		Celtis laevigata	77.4	31.3
		Bumelia lanuginosa	96.8	39.2
	S	Forestiera pubescens	1,192.2	482.7
		Smilax bona-nox	792.3	320.8
		Quercus virginiana	500.0	202.4
		Symphoricarpos orbiculatus	6,466.4	2,618.0
		Fraxinus texensis	612.6	248.0

* Growth form = O - overstory
U - understory
S - shrub

APPENDIX E. Vegetation parameters by vegetation level and season.

Study area Oak woodland	Parameters						
Species	Density	Dominance	% freq.	Relat. den.	Relat. dom.	Relat. freq.	Import. val.
OVERSTORY							
<u>Quercus stellata</u>	607.2	30,517.7	100.0	86.0	88.7	65.6	240.3
<u>Ulmus crassifolia</u>	32.7	1,021.1	17.5	4.6	3.0	11.5	19.1
<u>Juniperus virginiana</u>	17.2	676.1	10.0	2.4	1.9	6.6	10.9
<u>Prosopis glandulosa</u>	49.0	2,192.5	25.0	6.9	6.4	16.4	29.7
UNDERSTORY							
<u>Quercus stellata</u>	593.4	11,692.5	80.0	40.3	52.6	32.7	125.6
<u>Prosopis glandulosa</u>	105.4	1,369.6	25.0	7.2	6.2	10.2	23.6
<u>Ulmus crssifolia</u>	545.3	6,991.6	75.0	37.0	31.5	30.6	99.1
<u>Sophora afinis</u>	47.4	426.7	20.0	3.2	1.9	8.2	13.3
<u>Quercus marilandica</u>	86.7	898.8	20.0	5.9	4.0	8.2	18.1
<u>Crataegus spathulata</u>	38.2	458.7	10.0	2.6	2.1	4.1	8.8
<u>Bumelia lanuginosa</u>	57.0	398.9	15.0	3.9	1.8	6.1	11.8
SHRUBS							
<u>Quercus stellata</u>	179.0	907.4	22.5	5.7	1.6	8.2	15.5
<u>Ulmus crassifolia</u>	350.0	2,006.0	25.0	11.2	3.5	9.1	23.8
<u>Bumelia lanuginosa</u>	94.3	378.4	10.0	3.0	0.7	3.6	7.3
<u>Symphoricarpos orbiculatus</u>	189.3	915.3	17.5	6.0	1.6	6.4	14.0
<u>Forestiera pubescens</u>	140.6	7,050.5	15.0	4.5	12.2	5.5	22.2
<u>Opuntia phaeacantha</u>	168.3	17,976.7	22.5	5.4	31.0	8.2	44.6
<u>Smilax bona-nox</u>	395.3	2,566.6	35.0	12.6	4.4	12.7	29.7
<u>Prosopis glandulosa</u>	65.8	65.8	10.0	2.1	0.1	3.6	5.8
<u>Rhus aromatica</u>	1,218.3	24,724.6	75.0	38.9	42.6	27.3	108.8
<u>Opuntia leptocaulis</u>	128.2	691.5	12.5	4.1	1.2	4.5	9.8

APPENDIX E (continued)

Study area Oak woodland	Parameters						
Species	Density	Dominance	% freq.	Relat. den.	Relat. dom.	Relat. freq.	Import. val.
Juniperus virginiana	74.8	246.4	10.0	2.4	0.4	3.6	6.4
Quercus marilandica	64.6	322.9	10.0	2.1	0.6	3.6	6.3
Celits laevigata	64.9	129.8	10.0	2.1	0.2	3.6	5.9
SUMMER 1980							
Herbaceous							
Eragrostis curvula	0.8	7.5	5.0	3.9	7.6	4.3	15.8
Bouteloua hirsuta	2.0	6.9	15.0	10.4	7.0	12.8	30.2
Bouteloua rigidiseta	1.5	8.1	7.5	7.8	8.3	6.4	22.5
Rhus aromatica	1.0	16.9	7.5	5.2	17.2	6.4	28.8
Schizachyrium scoparium	0.3	0.6	2.5	1.3	0.6	2.1	4.0
Ruellia sp.	0.3	0.6	2.5	1.3	0.6	2.1	4.0
Bouteloua curtipendula	0.3	0.6	2.5	1.3	0.6	2.1	4.0
Aristida sp.	2.8	26.9	12.5	14.3	27.4	10.6	52.3
Sporobolus cryptandrus	1.0	2.5	10.0	5.2	2.5	8.5	16.2
Forestiera pubescens	0.3	3.8	2.5	1.3	3.8	2.1	7.2
Krameria lanceolata	0.3	3.8	2.5	1.3	3.8	2.1	7.2
Schrankia uncinata	0.3	0.6	2.5	1.3	0.6	2.1	4.0
Quercus stellata	0.3	0.6	2.5	1.3	0.6	2.1	4.0
Opuntia phaeacantha	0.3	0.6	2.5	1 3	0.6	2.1	4.0
Bumelia lanuginosa	0.3	3.8	2.5	1.3	3.8	2.1	7.2
UIF OWL01	5.0	10.0	15.0	26.0	10.2	12.8	49.0
UIF OWL03	0.5	1.3	5.0	2.6	1.3	4.3	8.2
UIF OWL04	1.8	2.5	15.0	9.1	2.5	12.8	24.4
Unknown Forbs	0.8	0.6	2.5	3.9	0.6	2.1	6.7

APPENDIX E (continued)

Study area Oak woodland	Parameters						
Species	Density	Dominance	% freq.	Relat. den.	Relat. dom.	Relat. freq.	Import. val.
FALL 1980							
Herbaceous							
<u>Kochia</u> <u>scoparia</u>	2.8	10.0	15.0	28.2	29.6	20.7	78.5
<u>Carex</u> <u>reniformis</u>	0.8	5.0	7.5	7.7	14.8	10.3	32.8
<u>Bouteloua</u> <u>rigidiseta</u>	0.5	1.3	5.0	5.1	3.7	6.9	15.7
<u>Aristida</u> sp.	1.0	1.9	7.5	10.3	5.5	10.3	26.1
<u>Sporobolus</u> <u>cryptandrus</u>	0.8	1.3	5.0	7.7	3.7	6.9	18.3
<u>Stipa</u> <u>leucotricha</u>	0.5	1.3	5.0	5.1	3.7	6.9	15.7
<u>Smilax</u> <u>bona-nox</u>	1.0	2.5	10.0	10.3	7.4	13.8	31.5
<u>Forestiera</u> <u>pubescens</u>	0.3	3.8	2.5	2.6	11.1	3.4	17.1
<u>Rhus</u> <u>aromatica</u>	0.3	0.6	2.5	2.6	1.9	3.4	7.9
<u>Bouteloua</u> <u>curtipendula</u>	0.5	3.8	2.5	5.1	11.1	3.4	19.6
<u>Bouteloua</u> <u>hirsuta</u>	0.8	0.6	2.5	7.7	1.9	3.4	13.0
UIF OWL03	0.8	1.9	7.5	7.7	5.5	10.3	23.5
WINTER 1981							
Herbaceous							
<u>Smilax</u> <u>bona-nox</u>	1.3	3.1	12.5	16.1	21.7	21.7	59.5
<u>Stipa</u> <u>leucothricha</u>	0.3	0.6	2.5	3.2	4.3	4.3	11.8
<u>Dichanthelium</u> <u>oligosanthes</u>	0.5	0.6	2.5	6.5	4.3	4.3	15.1
<u>Cirsium</u> <u>horridulum</u>	0.3	0.6	2.5	3.2	4.3	4.3	11.8
<u>Carex</u> <u>reniformis</u>	0.3	0.6	2.5	3.2	4.3	4.3	11.8
<u>Aristida</u> sp.	0.8	1.3	5.0	9.7	8.7	8.7	27.1
<u>Gallium</u> <u>aparine</u>	0.3	0.6	2.5	3.2	4.3	4.3	11.8
<u>Symphoricarpos</u> <u>orbiculatus</u>	0.8	1 [illegible]	[illegible]	9.7	8.7	8.7	27.1

APPENDIX E (continued)

Study area Oak woodland	Parameters						
Species	Density	Dominance	% freq.	Relat. den.	Relat. dom.	Relat. freq.	Import. val.
UIF OWL01	1.3	3.1	10.0	16.1	17.4	17.4	50.9
UIF OWL02	0.5	0.6	2.5	6.5	4.3	4.3	15.1
Vicia dasycarpa	1.8	2.5	10.0	22.6	17.4	17.4	15.4
SPRING 1981							
Herbaceous							
Bouteloua hirsuta	2.3	12.5	15.0	7.8	12.7	8.1	28.6
Carex reniformis	0.5	0.6	2.5	1.7	0.6	1.4	3.7
Rhus aromatica	0.5	4.4	5.0	1.7	4.5	2.7	8.9
Gallium aparine	0.8	1.3	5.0	2.6	1.3	2.7	6.6
Hymenoxys scaposia	1.0	1.3	5.0	3.5	1.3	2.7	7.5
Lespedeza fruticosa	0.5	4.4	5.0	1.7	4.5	2.7	8.9
Schedonnardus paniculatus	0.3	0.6	2.5	0.9	0.6	1.4	2.9
Schrankia uncinata	0.3	0.6	2.5	0.9	0.6	1.4	2.9
Nemastylis geminiflora	0.3	0.6	2.5	0.9	0.6	1.4	2.9
Bouteloua rigidiseta	0.8	1.9	7.5	2.6	1.9	4.0	8.5
Aristida sp.	0.3	0.6	2.5	0.9	0.6	1.4	2.9
Tragia sp.	2.5	5.0	20.0	8.7	5.1	10.8	24.6
Ulmus crassifolia	0.3	0.6	2.5	0.9	0.6	1.4	2.9
Stipa leucotricha	0.8	1.9	7.5	2.6	1.9	4.0	8.5
Prosopis glandulosa	0.8	16.9	7.5	2.6	17.2	4.1	23.9
Schizachyrium scoparium	0.3	0.6	2.5	0.9	0.6	1.4	2.9
Tridens albescens	0.5	1.3	5.0	1.7	1.3	2.7	5.7
Carex sp.	1.3	4.4	5.0	4.3	4.4	2.7	11.4
Bouteloua curtipendula	1.0	5.0	7.5	3.5	5.1	4.1	12.7
Bumelia lanuginosa	0.3	0.6	2.5	0.9	0.6	1.4	2.9
Symphoricarpos orbiculatus	0.3	0.6	2.5	0.9	0.6	1.4	2.9

APPENDIX E (continued)

Study area Oak woodland	Parameters						
Species	Density	Dominance	% freq.	Relat. den.	Relat. dom.	Relat. freq.	Import. val.
UIF OWL01	8.8	23.8	32.5	30.4	24.2	17.6	72.2
UIF OWL03	0.8	1.3	5.0	2.6	1.3	2.7	6.6
UIF 16287	1.0	1.9	7.5	3.5	1.9	4.1	9.5
UIF OWL05	1.3	1.9	7.5	4.3	1.9	4.1	9.5
UIF OWL06	1.0	1.3	5.0	3.5	1.3	2.7	7.5
Unknown Forbs	0.3	0.6	2.5	0.9	0.6	1.4	2.9

APPENDIX E (continued)

Study area Mesquite savannah	Parameters						
Species	Density	Dominance	% freq.	Relat. den.	Relat. dom.	Relat. freq.	Import. val.
SHRUBS							
Prosopis glandulosa	269.4	6,431.4	95.0	72.2	78.4	53.5	204.1
Bumelia lanuginosa	62.4	1,371.1	32.5	16.7	16.7	18.3	51.7
Celtis laevigata	17.8	287.9	20.0	4.8	3.5	11.3	19.6
Ulmus crassifolia	6.5	64.7	10.0	1.7	0.8	5.6	8.1
Crataegus spathulata	16.9	50.6	20.0	4.5	0.6	11.3	16.4
SUMMER 1980							
Herbaceous							
Bothriochloa sacchariodes	0.3	3.8	2.5	0.3	1.2	0.8	2.3
Lygodesmia juncea	0.3	0.6	2.5	0.3	0.2	0.8	1.3
Eragrostis curvula	5.3	54.4	35.0	6.3	17.0	11.9	35.2
Kochia scoparia	16.8	48.8	50.0	20.1	15.2	17.0	52.3
Croton capitatus	1.0	2.5	10.0	1.2	0.8	3.4	5.4
Xanthocephalum dracunculoides	40.1	100.6	67.5	48.8	31.4	22.9	103.1
Solidago altissima	4.8	29.4	20.0	5.7	9.2	6.8	21.7
Oenothera speciosa	0.5	1.3	5.0	0.6	0.4	1.7	2.7
Bumelia lanuginosa	0.3	0.6	2.5	0.3	0.2	0.8	1.3
Ambrosia psilostachya	3.5	7.5	17.5	4.2	2.3	5.9	12.4
Sorghum halepense	0.5	1.3	5.0	0.6	0.4	1.7	2.7
Schrankia uncinata	1.5	2.5	10.0	1.8	0.8	3.4	6.0
Dichanthelium oligosanthes	2.5	10.0	15.0	3.0	3.1	5.1	11.2
Opuntia phaecantha	0.2	3.8	2.5	0.3	1.2	0.8	2.3
UIG 1301	4.0	50.0	42.5	4.8	15.6	14.4	34.8
Unknown Forbs	1.5	3.1	7.5	1.8	1.0	2.5	5.3

APPENDIX E (continued)

Study area Mesquite savannah	Parameters						
Species	Density	Dominance	% freq.	Relat. den.	Relat. dom.	Relat. freq.	Import. val.
FALL 1980							
Herbaceous							
Galium aparine	9.0	1.9	7.5	9.9	1.0	2.9	13.8
Stipa leucotricha	3.3	25.0	17.5	3.6	13.2	6.9	23.7
Bromus tectorum	7.8	1.3	5.0	8.5	0.7	2.0	11.2
Oenothera triloba	19.8	20.6	45.0	21.6	10.8	17.6	50.1
Dicanthelium oligosanthes	1.8	3.1	12.5	1.9	1.6	4.9	8.4
Paspalum setaceum	0.5	1.3	5.0	0.6	0.7	2.0	3.3
Solidago altissima	9.5	18.8	37.5	10.4	9.9	14.7	35.0
Lupinus texensis	20.8	46.3	27.5	22.7	24.3	10.8	57.8
Sonchus asper	2.5	21.3	2.5	2.7	11.2	1.0	14.9
Eragrostis curvula	0.8	1.3	5.0	0.8	0.7	2.0	3.5
Sporobolus cryptandrus	4.3	26.3	20.0	4.7	13.8	7.8	26.3
Chloris vertcillata	0.3	0.6	2.5	0.3	0.3	1.0	1.6
Verbena bipinnatifida	1.0	1.9	7.5	1.1	1.0	2.9	5.0
Sorghum halepense	0.5	3.8	2.5	0.5	2.0	1.0	3.5
Aristida sp.	0.3	0.6	2.5	0.3	0.3	1.0	1.6
Xanthocephalum dracunculoides	0.3	0.6	2.5	0.3	0.3	1.0	1.6
Ambrosia psilostachya	0.3	0.6	2.5	0.3	0.3	1.0	1.6
Unknown Forbs	9.0	15.6	50.0	9.8	8.3	15.5	33.6
WINTER 1981							
Herbaceous							
Oxalis dillenii	3.0	6.9	15.0	0.9	2.1	2.7	5.7
Lupinus texensis	10.5	53.1	42.5	3.0	16.2	7.6	26.8
Ipomopsis rubra	0.5	0.6	2.5	0.1	0.2	0.5	0.8

APPENDIX E (continued)

Study area Mesquite savannah	Parameters						
Species	Density	Dominance	% freq.	Relat. den.	Relat. dom.	Relat. freq.	Import. val.
<u>Bromus tectorum</u>	74.3	18.1	37.5	21.2	5.5	6.7	33.4
<u>Chaerophyllum tainturieri</u>	47.5	29.4	67.5	13.5	9.0	12.1	34.6
<u>Galium aparine</u>	114.5	41.3	67.5	32.6	12.6	12.1	57.3
<u>Oenothera trilobata</u>	5.3	13.1	27.5	1.5	4.0	4.9	10.4
<u>Solidago altissima</u>	5.0	21.3	22.5	1.4	6.5	4.0	11.9
<u>Anemone heterophylla</u>	8.8	21.3	47.5	2.5	6.5	8.5	17.5
<u>Valerinella radiata</u>	37.5	20.6	32.5	10.7	6.3	5.8	22.8
<u>Dichanthelium oligosanthes</u>	1.0	5.0	7.5	0.3	1.5	1.3	3.1
<u>Verbena bipinnatifida</u>	3.0	4.4	17.5	0.9	1.3	3.1	5.3
<u>Cirsium horridulum</u>	0.3	0.6	2.5	0.1	0.2	0.5	0.8
<u>Sporobolus</u> sp.	1.3	5.0	7.5	0.4	1.5	1.3	3.2
<u>Bothriochloa sacchariodes</u>	0.3	0.6	2.5	0.1	0.2	0.5	0.8
<u>Stipa leucotricha</u>	3.3	13.8	17.5	0.9	4.2	3.1	8.2
<u>Paspalum setaceum</u>	1.3	7.5	5.0	0.4	2.3	0.9	3.6
<u>Kochia scoparium</u>	29.8	37.5	62.5	5.6	11.5	11.2	28.3
UIF 31115	3.0	5.0	20.0	0.9	1.5	3.6	6.0
Unknown Forbs	7.3	13.7	30.0	2.0	4.2	5.4	11.6
SPRING 1981							
Herbaceous							
<u>Bromus tectorum</u>	208.3	39.4	60.0	31.6	8.4	7.1	47.1
<u>Chaerophyllum tainturieri</u>	76.8	72.5	80.0	11.7	15.5	9.5	36.7
<u>Oenothera laciniata</u>	16.8	34.4	50.0	2.5	7.4	5.9	15.8
<u>Oxalis drummondii</u>	5.0	10.6	30.0	0.8	2.3	3.6	6.7
<u>Triodanis</u> sp.	9.8	6.3	25.0	1.5	1.3	3.0	5.8
<u>Galium aparine</u>	241.0	32.5	80.0	36.6	7.0	9.5	53.1

APPENDIX E (continued)

Study area Mesquite savannah	Parameters						
Species	Density	Dominance	% freq.	Relat. den.	Relat. dom.	Relat. freq.	Import. val.
Solidago altissima	7.3	18.8	27.5	1.1	4.0	3.3	8.4
Sonchus asper	1.5	3.1	12.5	0.2	0.7	1.5	2.4
Valerinella radiata	43.5	18.8	55.0	6.6	4.0	6.5	17.1
Anemone heterophylla	8.0	14.4	57.5	1.2	3.0	6.8	11.0
Carex reniformis	0.5	0.6	2.5	0.1	0.1	0.3	0.5
Aristida sp.	0.5	1.3	5.0	0.1	0.3	0.6	1.0
Stellaria media	0.5	0.6	2.5	0.1	0.1	0.3	0.5
Stipa leucotricha	5.0	14.4	20.0	0.8	3.1	2.4	6.3
Lupinus texensis	9.5	56.3	45.0	1.4	12.0	5.3	18.7
Sorghum halepense	5.3	14.4	20.0	0.8	3.1	2.4	6.3
Schrankia uncinata	1.8	3.8	15.0	0.3	0.8	1.8	2.9
Verbena bipinnatifida	1.8	2.5	10.0	0.3	0.5	1.2	2.0
Euphorbia spathulata	1.5	1.3	5.0	0.2	0.3	0.6	1.1
Convolvulus arvensis	0.8	1.3	5.0	0.1	0.3	0.6	1.0
Lithospermum incisum	0.5	1.3	5.0	0.1	0.3	0.6	1.0
Hordeum pusillum	6.0	11.3	20.0	0.9	2.4	2.4	5.7
Sporobolus cryptandrus	5.8	35.6	22.5	0.9	7.6	2.7	11.2
Solanum rostratum	0.3	0.6	2.5	0.1	0.1	0.3	0.5
Dichanthelium oligosanthes	1.3	5.6	10.0	0.2	1.2	1.2	2.6
Draba platycarpa	4.0	5.6	10.0	0.6	1.2	1.2	3.0
Ambrosia psilostachya	1.0	3.8	2.5	0.2	0.8	0.3	1.3
Evax verna	3.8	1.9	7.5	0.6	0.4	0.9	1.9
Bothriochloa sacchariodes	0.3	0.6	2.5	0.1	0.1	0.3	0.5
Castilleja purpurea	0.3	0.6	2.5	0.1	0.1	0.3	0.5
Kochia scoparium	15.3	22.5	55.0	2.3	4.8	6.5	13.6

APPENDIX E (continued)

Study area Cedar elm woodland			Parameters				
Species	Density	Dominance	% freq.	Relat. den.	Relat. dom.	Relat. freq.	Import. val.
OVERSTORY							
Ulmus crassifolia	344.0	20,455.3	100.0	66.6	59.8	49.4	175.8
Quercus vrginiana	63.1	7,826.7	32.5	12.2	22.9	16.1	51.2
Fraxinus pensylvanica	47.3	2,789.7	30.0	9.2	8.2	14.8	32.2
Sapindus drummondii	39.4	1,857.7	20.0	7.6	5.4	9.9	22.9
Maclura pomifera	7.4	333.3	10.0	1.4	1.0	4.9	7.3
Juniperus virginiana	15.7	925.0	10.0	3.0	2.7	4.9	10.6
UNDERSTORY							
Fraxinus pensylvanica	1,408.2	17,917.7	92.5	44.4	45.0	35.9	125.3
Ulmus crassifolia	557.4	11,355.3	55.0	17.6	28.5	21.4	67.5
Celtis laevigata	77.4	461.0	10.0	2.4	1.2	3.9	7.5
Bumelia lanuginosa	96.8	955.9	10.0	3.0	2.4	3.9	9.3
Morus rubra	44.9	179.0	10.0	1.4	0.5	3.9	5.8
Crataegus spathulata	89.9	718.0	10.0	2.8	1.8	3.9	8.5
Sapindus drummondii	214.5	3,931.2	20.0	6.8	9.9	7.8	24.6
Quercus macrocarpa	64.6	323.0	10.0	2.0	0.8	3.9	6.7
Prosopis glandulosa	129.2	1,291.9	20.0	4.1	3.3	7.8	15.2
Juniperus virginiana	44.4	888.2	10.0	1.4	2.2	3.9	7.5
Quercus virginiana	44.4	1,776.4	10.0	1.4	4.5	3.9	9.8
SHRUBS							
Symphoricarpos orbiculatus	6,466.4	78,014.6	85.0	57.6	63.3	35.4	156.3
Bumelia lanuginosa	397.5	397.5	10.0	3.5	0.3	4.2	8.0
Quercus virginiana	500.5	500.5	10.0	4.5	0.4	4.2	9.1
Fraxinus pensylvanica	612.6	612.6	17.5	5.5	0.5	7.3	13.3

APPENDIX E (continued)

Study area Cedar elm woodland	Parameters						
Species	Density	Dominance	% freq.	Relat. den.	Relat. dom.	Relat. freq.	Import. val.
Smilax bona-nox	792.3	1,689.6	17.5	7.1	1.4	7.3	15.8
Forestiera pubescens	1,192.3	29,299.0	35.0	10.6	23.8	14.6	49.0
Opuntia phaeacantha	291.4	1,529.0	15.0	2.6	1.2	6.3	10.1
Ulmus crassifolia	397.2	626.8	10.0	3.5	0.5	4.2	8.2
Sapindus drummondii	156.9	156.9	20.0	1.4	0.1	8.3	9.8
Juniperus virginiana	78.5	392.3	10.0	0.7	0.3	4.2	5.2
Yucca louisianensis	335.3	10,058.0	10.0	3.0	8.2	4.2	15.4
SUMMER 1980							
Herbaceous							
Symphoricarpos orbiculatus	1.8	16.3	15.0	3.6	8.6	9.1	21.3
Carex reniformis	24.0	129.4	52.5	48.7	68.4	31.8	148.9
Forestiera pubescens	0.5	4.4	5.0	1.0	2.3	3.0	6.3
Celtis laevigata	0.8	4.4	5.0	1.5	2.3	3.0	6.8
Ulmus crassifolia	10.3	2.5	17.5	20.8	1.3	10.6	32.7
Bouteloua rigidiseta	3.5	10.0	15.0	7.1	5.3	9.1	21.5
Ruellia sp.	0.3	0.6	2.5	0.5	0.3	1.5	2.3
Quercus virginiana	1.8	2.5	12.5	3.6	1.3	7.6	12.5
Stipa leucotricha	1.0	1.3	5.0	2.0	0.7	3.0	5.7
Croton capitatus	2.5	2.5	7.5	5.1	1.3	4.5	10.9
Xanthocephalum dracunculoides	0.3	0.6	2.5	0.5	0.3	1.5	2.3
Viola missoruiensis	0.5	0.6	2.5	1.0	0.3	1.5	2.8
Indigofera miniata	0.3	0.6	2.5	0.5	0.3	1.5	2.3
Dichanthelium oligosanthes	0.5	1.3	5.0	1.0	0.7	3.0	4.7
Smilax bona-nox	0.8	1.9	7.5	1.5	1.0	4.5	7.0

APPENDIX E (continued)

Study area Cedar elm woodland	Parameters						
Species	Density	Dominance	% freq.	Relat. den.	Relat. dom.	Relat. freq.	Import. val.
FALL 1980							
Herbaceous							
Quercus virginiana	0.8	5.0	7.5	2.5	4.3	5.4	12.2
Symphoricarpos orbiculatu	2.0	4.4	17.5	6.7	3.8	12.5	23.0
Aristida sp.	1.5	4.0	7.5	5.0	3.5	5.4	13.9
Tragia macrocarpa	0.3	0.6	2.5	0.8	0.5	1.8	3.1
Stipa leucotricha	1.0	3.8	2.5	3.3	3.2	1.8	8.3
Carex reniformis	17.8	81.3	52.5	59.2	70.3	37.5	167.0
Paspalum setaceum	0.3	0.6	2.5	0.8	0.5	1.8	3.1
Lupinus texensis	0.3	0.6	2.5	0.8	0.5	1.8	3.1
Smilax bona-nox	0.5	1.3	5.0	1.7	1.1	3.6	6.4
Sonchus asper	0.8	1.9	7.5	2.5	1.6	5.4	9.5
Bumelia lanuginosa	0.5	1.3	5.0	1.7	1.1	3.6	6.4
Geum canadense	0.5	1.3	5.0	1.7	1.1	3.6	6.4
Elymus canadensis	1.3	1.3	5.0	4.2	1.1	3.6	8.9
Forestiera pubescens	0.3	3.6	2.5	0.8	3.2	1.8	5.8
Oxalis dillenii	1.0	1.3	5.0	3.3	1.1	3.6	8.0
Galium aparine	0.3	0.6	2.5	0.8	0.5	1.8	3.1
Unknown Forbs	1.0	1.3	5.0	3.3	1.1	3.6	8.0
WINTER 1981							
Herbaceous							
Symphoricarpos orbiculatus	1.8	7.5	17.5	1.9	5.0	6.7	13.6
Chaerophyllum tainturieri	19.8	20.0	42.5	21.9	13.5	16.3	51.7
Lupinus texensis	2.5	5.6	10.0	2.8	3.8	3.8	10.4
Allium drummondii	2.0	1.9	7.5	2.2	1.3	2.9	6.4
Indigofera miniata	0.5	0.6	2.5	0.6	0.4	1.0	2.0

APPENDIX E (continued)

Study area Cedar elm woodland	Parameters						
Species	Density	Dominance	% freq.	Relat. den.	Relat. dom.	Relat. freq.	Import. val.
Anenome heterophylla	1.3	2.5	10.0	1.4	1.7	3.8	6.9
Dichondra recurvata	3.8	5.6	10.0	4.2	3.8	3.8	11.8
Dichanthelium oligosanthes	0.3	0.6	2.5	0.3	0.4	1.0	1.7
Carex reniformis	18.3	57.5	45.0	20.0	38.7	17.3	76.0
Galium aparine	7.8	13.1	32.5	8.6	8.8	12.5	29.9
Bromus tectorum	2.0	1.9	7.5	2.2	1.3	2.9	6.4
Oxalis drummondii	0.5	1.3	5.0	0.6	0.8	1.9	3.3
Elymus canadensis	5.3	11.9	22.5	5.8	8.0	8.6	22.4
Nemophila phacelioides	2.8	3.8	15.0	3.0	2.5	5.8	11.3
Lactuca serriola	0.3	0.6	2.5	0.3	0.4	1.0	1.7
Lamium amplexicauli	0.5	1.3	5.0	0.6	0.8	1.9	3.3
Viola missouriensis	0.5	0.6	2.5	0.6	0.4	1.0	2.0
Valerinella radiata	3.3	4.4	5.0	3.6	2.9	1.9	8.4
Stellaria media	5.0	3.8	2.5	5.5	2.5	1.0	9.0
Stipa leucotricha	1.5	2.5	10.0	1.7	1.7	3.8	7.2
Unknown Forbs	0.5	1.3	5.0	0.6	0.8	1.9	3.3
SPRING 1981							
Herbaceous							
Galium aparine	17.3	34.4	40.0	22.6	13.4	12.4	48.4
Oxalis drummondii	1.3	3.1	12.5	1.6	1.2	3.9	6.7
Aristida sp.	0.8	1.9	7.5	1.0	0.7	2.3	4.0
Symphoricarpos orbiculatus	5.8	56.9	45.0	7.5	22.1	14.0	43.6
Fraxinus pensylvanica	0.3	0.6	2.5	0.3	0.2	0.8	1.3
Solidago altissima	0.3	0.6	2.5	0.3	0.2	0.8	1.3
Lactuca serriola	2.3	19.4	15.0	3.0	7.5	4.7	15.2
Stipa leucotricha	2.3	7.5	17.5	3.0	2.9	5.4	11.3

APPENDIX E (continued)

Study area Cedar elm woodland	Parameters						
Species	Density	Dominance	% freq.	Relat. den.	Relat. dom.	Relat. freq.	Import. val.
Carex reniformis	17.8	43.8	37.5	23.3	17.0	11.6	51.9
Parthenocissus quinquefolia	1.3	8.8	10.0	1.6	3.4	3.1	8.1
Forestiera pubescens	0.5	3.8	2.5	0.7	1.5	0.8	3.0
Celtis laevigata	0.3	0.6	2.5	0.3	0.2	0.8	1.3
Ulmus crassifolia	0.3	0.6	2.5	0.3	0.2	0.8	1.3
Elymus canadensis	2.0	5.6	10.0	2.6	2.2	3.1	7.9
Bumelia lanuginosa	0.3	0.6	2.5	0.3	0.2	0.8	1.3
Bromus tectorum	0.8	0.6	2.5	1.0	0.2	0.8	2.0
Lupinus texensis	1.0	4.4	5.0	1.3	1.7	1.6	4.6
Chaerophyllum tainturieri	12.3	31.9	40.0	16.1	12.4	12.4	40.9
Chloris verticillata	0.3	0.6	2.5	0.3	0.2	0.8	1.3
Dichondra recurvata	0.5	1.3	5.0	0.7	0.5	1.6	2.8
Dichanthelium oligpsanthes	0.5	1.3	5.0	0.7	0.5	1.6	2.8
Quercus virginiana	0.3	0.6	2.5	0.3	0.2	0.8	1.3
Valerinella radiata	0.3	0.6	2.5	0.3	0.2	0.8	1.3
Smilax bona-nox	0.3	0.6	2.5	0.3	0.2	0.8	1.3
Tragia macrocarpa	1.0	1.9	7.5	1.3	0.7	2.3	4.3
Vernonia baldwinii	0.3	3.8	2.5	0.3	1.5	0.8	2.6
Nemophilia phacelioides	1.8	8.1	7.5	2.3	3.2	2.3	7.8
Triodanis sp.	0.8	0.6	2.5	1.0	0.2	0.8	2.0
Urtica chamaedryoides	2.5	9.4	12.5	3.3	3.6	3.9	10.8
Stellaria media	1.5	2.5	10.0	2.0	1.0	3.1	6.1
Lamium amplexicauli	0.3	0.6	2.5	0.3	0.2	0.8	1.3

APPENDIX E (continued)

Study area Mesquite/cedar elm parkland	Parameters						
Species	Density	Dominance	% freq.	Relat. den.	Relat. dom.	Relat. freq.	Import. val.
OVERSTORY							
Prosopis glandulosa	227.5	11,620.8	87.5	61.6	52.5	46.7	160.8
Ulmus crassifolia	98.8	5,343.6	52.5	26.8	25.2	28.0	78.9
Quercus stellata	15.2	3,962.5	17.5	4.1	17.9	9.3	31.4
Quercus marilandica	8.6	770.9	10.0	2.3	3.8	5.3	11.5
Celtis laevigata	19.1	420.0	20.0	5.2	1.9	10.7	17.8
UNDERSTORY							
Ulmus crassifolia	350.1	4,623.4	85.0	41.1	46.2	31.8	119.0
Celtis laevigata	41.4	119.2	17.5	4.9	1.9	6.5	53.3
Prosopis glandulosa	244.5	3,188.8	65.0	28.7	31.8	24.3	84.9
Juniperus virginiana	18.1	270.9	10.0	2.1	2.7	3.7	8.6
Crataegus spathulata	36.1	451.6	20.0	4.2	4.5	7.5	16.2
Zanthoxylum clava-herculis	52.6	431.7	20.0	6.2	4.3	7.5	18.0
Bumelia lanuginosa	17.1	205.0	10.0	2.0	2.0	3.7	7.7
Carya texana	18.1	180.6	10.0	2.1	1.8	3.7	7.6
Quercus stellata	39.2	269.9	10.0	4.6	2.7	3.7	11.0
Quercus marilandica	34.2	205.0	20.0	4.0	2.0	7.5	13.5
SHRUBS							
Forestiera pubescens	286.4	1,058.3	25.0	11.7	7.7	9.0	28.4
Smilax bona-nox	413.5	964.1	32.5	16.9	7.0	11.7	35.6
Opuntia leptocaulis	588.4	6,110.2	50.0	24.1	44.4	18.0	86.5
Ulmus crassifolia	351.4	811.0	47.5	14.4	5.9	17.1	37.4
Prosopis glandulosa	70.7	255.1	10.0	2.9	1.9	3.6	8.4
Celtis laevigata	48.5	108.9	10.0	2.0	0.8	3.6	6.4

APPENDIX E (continued)

Study area Mesquite/cedar elm parkland	Parameters						
Species	Density	Dominance	% freq.	Relat. den.	Relat. dom.	Relat. freq.	Import. val.
Quercus stellata	123.2	232.0	12.5	5.0	1.7	4.5	11.2
Carya texana	149.5	149.0	20.0	6.1	1.1	7.2	14.4
Rhus aromatica	35.4	3,136.6	10.0	1.4	22.8	3.6	27.8
Zanthoxylum clava-herculis	83.7	130.7	10.0	3.4	1.0	3.6	8.0
Symphoricarpos orbiculatus	68.2	192.6	10.0	2.8	1.4	3.6	7.8
Crataegus spathulata	63.1	93.2	10.0	2.6	0.7	3.6	6.9
Viburnum rufidulum	39.8	398.4	10.0	1.6	2.9	3.6	8.1
Gleditisia triacanthos	39.8	39.8	10.0	1.6	0.3	3.6	5.5
Rhus toxicodendron	79.7	79.7	10.0	3.7	0.6	3.6	7.4
SUMMER 1981							
Herbaceous							
Croton capitatus	1.0	2.5	10.0	3.7	0.9	6.1	10.7
Dichanthelium oligosanthes	8.7	86.3	35.0	32.1	31.4	21.2	84.7
Stipa leucotricha	5.0	26.9	32.5	18.4	9.8	19.7	47.8
Forestiera pubescens	0.3	9.4	2.5	0.9	3.4	1.5	5.8
Smilax bona-nox	1.3	0.6	12.5	4.6	0.2	7.6	12.4
Schizachyrium scoparium	3.0	59.4	22.5	11.0	21.6	13.6	46.2
Sporobolus cryptandrus	0.3	9.4	2.5	0.9	3.4	1.5	5.8
Ambrosia trifida	0.3	0.6	2.5	0.9	0.2	1.5	2.6
Galium aparine	0.5	4.4	5.0	1.8	1.6	3.0	6.4
Juniperus virginiana	0.3	0.6	2.5	0.9	0.2	1.5	2.6
Panicum obtusium	0.5	24.4	2.5	1.8	8.9	1.5	12.2
Eragrostis curvula	0.3	0.6	2.5	0.9	0.2	1.5	2.6
Ruellia sp.	2.8	16.3	15.0	10.1	5.9	9.1	25.1
Juncus tenius	0.5	1.3	5.0	1.8	0.5	3.0	5.3
Xanthocephalum dracunculoides	0.3	0.6	2.5	0.9	0.2	1.5	2.6

APPENDIX E (continued)

Study area Mesquite/cedar elm parkland	Parameters						
Species	Density	Dominance	% freq.	Relat. den.	Relat. dom.	Relat. freq.	Import. val.
Unknown Forbs	2.5	31.9	10.0	9.2	11.6	6.1	26.9
FALL 1981							
Herbaceous							
Dichanthelium oligosanthes	24.3	131.3	70.0	4.3	39.1	30.4	73.8
Schizachyrium scoparium	2.5	35.0	17.5	0.4	10.4	7.6	18.4
Carex reniformis	0.8	5.0	7.5	0.1	1.5	3.3	4.9
Stipa leucotricha	15.5	72.4	57.5	2.7	21.6	25.0	48.3
Tragia macrocarpa	0.5	1.3	5.0	0.1	0.4	2.2	2.7
Aristida sp.	0.3	3.8	2.5	0.1	1.1	1.1	2.3
Smilax bona-nox	0.3	0.6	2.5	0.1	0.2	1.1	1.4
Ulmus crassifolia	0.8	5.0	7.5	0.1	1.5	3.3	4.9
Symphoricarpos orbiculatus	0.3	3.8	2.5	0.1	1.1	1.1	2.3
Bouteloua curtipendula	0.3	0.6	2.5	0.1	0.2	1.1	1.4
Paspalum setaceum	2.0	12.5	12.5	0.4	3.7	5.4	9.5
Krameria lanceolata	3.0	6.9	15.0	0.5	2.0	6.5	9.1
Ruellia sp.	0.3	0.6	2.5	0.1	0.2	1.1	1.4
Bromus tectorum	517.5	51.5	15.0	90.9	15.3	6.5	112.7
Bothriochloa saccharoides	0.3	0.6	2.5	0.1	0.2	1.1	1.4
Opuntia leptocaulis	0.3	0.6	2.5	0.1	0.2	1.1	1.4
Ambrosia psilostachya	1.0	4.4	5.0	0.2	1.3	2.2	3.7
WINTER 1981							
Herbaceous							
Stipa leucotricha	14.0	37.5	50.0	2.8	18.3	12.7	33.8
Bromus tectorum	391.0	45.0	50.0	76.8	22.0	12.7	111.5
Dichanthelium oligosanthes	34.3	43.1	62.5	6.7	21.0	15.8	43.5

APPENDIX E (continued)

Study area Mesquite/cedar elm parkland	Parameters						
Species	Density	Dominance	% freq.	Relat. den.	Relat. dom.	Relat. freq.	Import. val.
<u>Chaerophyllum tainturieri</u>	5.5	6.3	15.0	1.1	3.0	3.8	7.9
<u>Oxalis dillenii</u>	2.0	4.4	17.5	0.4	2.1	4.4	6.9
<u>Verbena bipinnatifida</u>	1.3	2.5	10.0	0.2	1.2	2.5	3.9
<u>Galium aparine</u>	19.0	11.3	32.5	3.7	5.5	8.2	17.4
<u>Panicum obtusum</u>	1.0	4.4	5.0	0.2	2.1	1.3	3.6
<u>Valerinella radiata</u>	7.8	3.1	12.5	1.5	1.5	3.2	6.2
<u>Croton capitatus</u>	1.3	1.9	7.5	0.2	0.9	1.9	3.0
<u>Cirsium horridulum</u>	1.0	1.9	7.5	0.2	0.9	1.9	3.0
<u>Vicia dasycarpa</u>	2.5	8.8	22.5	0.5	4.3	5.7	10.5
<u>Commelina erecta</u>	1.5	1.3	5.0	0.3	0.6	1.3	2.2
<u>Allium drummondii</u>	0.3	0.6	2.5	0.1	0.3	0.6	1.0
<u>Carex reniformis</u>	1.0	1.3	5.0	0.2	0.6	1.3	2.1
<u>Opuntia phaeacantha</u>	0.3	3.8	2.5	0.1	1.8	0.6	2.5
<u>Schizachyrium scoparium</u>	0.8	5.0	7.5	0.1	2.4	1.9	4.4
<u>Smilax bona-nox</u>	0.3	0.6	2.5	0.1	0.3	0.6	1.0
UIF 13243	9.0	3.8	15.0	1.8	1.8	3.8	7.4
Unknown Forbs	14.5	15.6	50.0	2.7	7.5	12.6	22.8
SPRING 1981							
Herbaceous							
<u>Stipa leucotricha</u>	26.5	95.0	75.0	5.1	25.1	14.6	44.8
<u>Dichanthelium oligosanthes</u>	9.5	31.3	37.5	1.8	8.3	7.3	17.4
<u>Galium aparine</u>	34.5	26.9	57.5	6.6	7.1	11.2	24.9
<u>Bromus tectorum</u>	389.0	73.8	65.0	74.8	19.5	12.7	107.0
<u>Vicia dasycarpa</u>	3.0	4.4	17.5	0.6	1.2	3.4	5.2
<u>Carex reniformis</u>	1.0	1.9	7.5	0.2	0.5	1.5	2.2
<u>Chaerophyllum tainturieri</u>	6.5	20.0	20.0	1.3	5.3	3.9	10.5

APPENDIX E (continued)

Study area Mesquite/cedar elm parkland	Parameters						
Species	Density	Dominance	% freq.	Relat. den.	Relat. dom.	Relat. freq.	Import. val.
Oxalis dillenii	4.0	9.4	25.0	0.8	2.5	4.9	8.2
Physalis viscosa	4.5	3.8	5.0	0.1	0.3	1.0	1.4
Triodanis sp.	4.5	3.8	15.0	0.9	1.0	2.9	4.8
Lactuca canadensis	0.5	1.3	5.0	0.1	0.3	1.0	1.4
Euphorbia spathulata	2.5	3.8	15.0	0.5	1.0	2.9	4.4
Bromus unioloides	2.5	5.0	7.5	0.5	1.3	1.5	3.3
Allium drummondii	1.0	1.3	5.0	0.2	0.3	1.0	1.5
Hedeoma hispidum	2.5	0.6	2.5	0.5	0.2	0.5	1.2
Stellaria media	4.8	13.8	17.5	0.9	3.6	3.4	7.9
Tragia macrocarpa	0.3	0.6	2.5	0.1	0.2	0.5	0.8
Lindheimera texana	0.8	4.4	5.0	0.1	1.2	1.0	2.3
Valerinella radiata	5.3	5.6	10.0	1.0	1.5	2.0	4.5
Ambrosia trifida	1.0	2.5	10.0	0.2	0.6	2.0	2.8
Rhus toxicodendron	0.5	3.8	2.5	0.1	1.0	0.5	1.6
Nothoscordum bivalve	0.3	0.6	2.5	0.1	0.2	0.5	0.8
Ulmus crassifolia	0.5	1.3	5.0	0.1	0.3	1.0	1.4
Schizachyrium scoparium	0.8	16.3	5.0	0.1	4.3	1.0	5.4
Aristida sp.	0.3	0.6	2.5	0.1	0.2	0.5	0.8
Oenothera speciosa	0.5	3.8	2.5	0.1	1.0	0.5	1.6
Vicia leavenworthii	0.8	1.3	5.0	0.1	0.3	1.0	1.4
Forestiera pubescens	0.3	0.6	2.5	0.1	0.2	0.5	0.8
Rubus sp.	0.3	0.6	2.5	0.1	0.2	0.5	0.8
Geranium carolinianum	0.3	0.6	2.5	0.1	0.2	0.5	0.8
Bothriochola saccharoides	0.5	3.8	2.5	0.1	1.0	0.5	1.6
Opuntia leptocaulis	0.3	0.6	2.5	0.1	0.2	0.5	0.8
Anemone heterophylla	0.3	0.6	2.5	0.1	0.2	0.5	0.8
Cirsium horridulum	0.3	3.8	2.5	0.1	1.0	0.5	1.6

APPENDIX E (continued)

Study area Mesquite/cedar elm parkland	Parameters						
Species	Density	Dominance	% freq.	Relat. den.	Relat. dom.	Relat. freq.	Import. val.
Solanum elaeagnifolium	0.3	0.6	2.5	0.1	0.2	0.5	0.8
Plantago helleri	7.0	18.8	15.0	1.3	5.0	2.9	9.2
Unknown Forbs	7.5	15.0	47.5	1.4	4.0	9.2	14.6

APPENDIX E (continued)

Study area Riparian forest	Parameters						
Species	Density	Dominance	% freq.	Relat. den.	Relat. dom.	Relat. freq.	Import. val.
OVERSTORY							
Maclura pomifera	16.4	964.1	20.0	5.1	3.6	6.4	15.1
Ulmus crassifolia	163.3	16,593.9	95.0	51.1	61.5	30.4	143.0
Crataegus spathulata	4.5	107.0	10.0	1.4	0.4	3.2	5.0
Celtis laevigata	11.6	1,202.0	22.5	3.6	4.5	7.2	15.3
Quercus macrocarpa	4.5	449.0	10.0	1.4	1.7	3.2	6.3
Prosopis glandulosa	5.9	294.3	10.0	1.8	1.1	3.2	6.1
Carya illinoinensis	13.1	1,670.7	15.0	4.1	6.2	4.8	15.1
Gleditsia triacanthos	7.4	294.8	10.0	2.3	1.1	3.2	6.6
Bumelia lanuginosa	3.0	567.6	15.0	0.9	2.1	4.8	7.8
Acer negundo	5.7	509.4	10.0	1.8	1.9	3.2	6.9
Sapindus drummondii	44.7	1,475.0	50.0	14.0	5.5	16.0	35.5
Morus rubra	22.4	1,117.0	20.0	7.0	4.1	6.4	17.5
Fraxinus pensylvanica	17.2	1,734.9	25.0	5.4	6.4	8.0	19.8
UNDERSTORY							
Ulmus crassifolia	212.5	4,825.7	92.5	21.3	31.7	25.2	78.2
Fraxinus pensylvanica	46.1	615.5	17.5	4.6	4.0	4.8	13.5
Crataegus spathulata	50.7	951.3	17.5	5.1	6.2	4.8	16.1
Celtis laevigata	196.4	2,490.6	50.0	19.7	16.3	13.6	49.6
Bumelia lanuginosa	76.1	927.8	25.0	7.6	6.1	6.8	20.5
Ilex decidua	18.8	375.2	10.0	1.9	2.5	2.7	7.1
Sorphora affinis	18.8	93.8	10.0	1.9	0.6	2.7	5.2
Maclura pomifera	67.5	1,612.8	27.5	6.8	10.6	7.5	24.9
Gleditsia triacanthos	35.3	430.9	17.5	3.5	2.8	4.8	11.1
Prosopis glandulosa	27.1	135.4	10.0	2.7	0.9	2.7	6.3

APPENDIX E (continued)

Study area Riparian forest	Parameters						
Species	Density	Dominance	% freq.	Relat. den.	Relat. dom.	Relat. freq.	Import. val.
Carya texana	70.7	388.0	10.0	7.1	2.5	2.7	12.3
Sapindus drummondii	157.6	1,600.7	60.0	15.8	10.5	16.3	42.6
Acer negundo	11.0	523.7	10.0	1.1	3.4	2.7	7.2
Morus rubra	10.6	263.8	10.0	1.1	1.7	2.7	5.5
SHRUBS							
Symphoricarpos orbiculatus	2,562.5	13,038.5	67.5	41.5	27.8	22.9	92.2
Gleditsia triacanthos	17.0	1,695.0	10.0	0.3	3.6	3.4	7.3
Ulmus crassifolia	341.4	345.9	15.0	5.5	0.7	5.1	11.3
Forestiera pubescens	1,533.1	25,700.0	35.0	24.8	54.7	11.9	91.4
Sapindus drummondii	109.3	436.2	30.0	1.8	0.9	10.2	12.9
Celtis laevigata	400.9	681.7	25.0	6.5	1.5	3.4	16.4
Smilax bona-nox	594.5	3,706.2	55.0	9.6	7.9	18.6	36.1
Crataegus spathulata	294.7	589.4	10.0	4.8	1.3	3.4	9.5
Bumelia lanuginosa	95.7	170.7	25.0	1.6	0.4	8.5	10.5
Fraxinus pensylvanica	204.4	426.0	12.5	3.3	0.9	4.2	8.4
Parthenocissus quinquefolia	17.0	169.0	10.0	0.3	0.4	3.4	4.1
Celtis laevigata	1,112.5	13.4	40.0	12.5	0.3	16.7	29.5
Smilax bona-nox	890.0	8.9	20.0	10.0	0.2	8.3	18.5
SUMMER 1980							
Herbaceous							
Carex reniformis	18.3	198.4	90.0	70.9	81.7	57.1	209.7
Dichondra recurvata	0.8	0.6	2.5	2.9	0.3	1.6	4.8
Ruellia sp.	0.5	4.4	5.0	1.9	1.8	3.2	6.9
Elymus canadensis	2.5	2.5	22.5	9.7	1.0	14.3	25.0
Paspalum setaceum	0.3	0.6	2.5	1.0	0.3	1.6	2.9

APPENDIX E (continued)

Study area Riparian forest	Parameters						
Species	Density	Dominance	% freq.	Relat. den.	Relat. dom.	Relat. freq.	Import. val.
Ulmus crassifolia	0.5	1.3	5.0	1.9	0.5	3.2	5.6
Forestiera pubescens	1.3	26.9	12.5	4.9	11.1	7.9	23.9
Smilax bona-nox	0.8	2.5	7.5	2.9	1.0	4.8	8.7
Symphoricarpos orbiculatus	0.5	1.3	5.0	1.9	0.5	3.2	5.6
Bumelia lanuginosa	0.3	3.8	2.5	1.0	1.5	1.6	4.1
Passiflora lutea	0.3	0.6	2.5	1.0	0.3	1.6	2.9
FALL 1980							
Herbaceous							
Carex reniformis	16.5	90.6	57.5	35.5	19.1	29.5	84.1
Symphoricarpos orbiculatus	3.3	33.1	27.5	13.0	3.8	14.1	30.9
Daucus pusillus	11.0	6.9	15.0	2.7	12.7	7.7	23.1
Tragia macrocarpa	1.5	3.1	12.5	1.2	1.7	6.4	9.3
Stipa leucotricha	1.0	4.4	5.0	1.7	1.2	2.6	5.5
Elymus canadensis	13.3	83.8	55.0	32.8	15.3	28.2	76.3
Dichanthelium oligosanthes	0.3	0.6	2.5	0.2	0.3	1.3	1.8
Galium aparine	0.8	0.6	7.5	0.2	0.9	3.8	4.9
Bumelia lanuginosa	0.3	0.6	2.5	0.2	0.3	1.3	1.8
Forestiera pubescens	0.5	9.4	2.5	3.7	0.6	1.3	5.6
Smilax bona-nox	0.3	0.6	2.5	0.2	0.3	1.3	1.8
Bromus tectorum	37.5	21.3	2.5	8.3	43.4	1.3	53.0
WINTER 1981							
Herbaceous							
Bromus tectorum	136.8	16.3	5.0	62.2	5.5	1.8	69.5
Carex reniformis	16.5	50.6	55.5	7.5	17.2	20.0	44.7
Chaerophyllum tainturieri	12.8	18.1	35.0	5.8	6.1	12.7	24.6

APPENDIX E (continued)

Study area Riparian forest	Parameters						
Species	Density	Dominance	% freq.	Relat. den.	Relat. dom.	Relat. freq.	Import. val.
Symphoricarpos orbiculatus	0.5	4.4	5.0	0.2	1.5	1.8	3.5
Stipa leucotricha	0.5	0.6	2.5	0.2	0.2	0.9	1.3
Elymus canadensis	23.3	168.8	77.5	10.6	57.2	28.2	96.0
Urtica chamaedeyoides	10.5	13.8	30.0	4.8	4.8	4.7	14.3
Galium aparine	6.3	5.6	22.5	2.8	1.9	8.2	12.9
Tragia macrocarpa	0.3	0.6	2.5	0.1	0.2	0.9	1.2
Valerinella radiata	0.5	0.6	2.5	0.2	0.2	0.9	1.3
Allium drummondii	0.5	1.3	5.0	0.2	0.3	1.8	2.3
Aster sp.	4.5	5.0	7.5	2.0	1.7	2.7	6.4
Anemone heterophylla	4.8	6.3	12.5	2.2	2.1	4.5	8.8
Lamium amplexicauli	0.3	0.6	2.5	0.1	0.2	0.9	1.2
SPRING 1981							
Herbaceous							
Symphoricarpos orbiculatus	4.0	59.4	22.5	2.2	10.6	5.2	18.0
Elymus canadensis	34.3	198.8	92.5	19.0	35.5	21.5	76.0
Carex reniformis	37.5	148.1	75.0	20.8	26.4	17.4	64.6
Daucus pusillus	15.8	56.9	45.0	8.8	10.1	10.5	29.4
Galium aparine	5.5	12.5	37.5	3.1	2.2	8.7	14.0
Forestiera pubescens	1.0	17.5	10.0	0.6	3.1	2.3	6.0
Bromus tectorum	57.0	9.4	12.5	31.7	1.7	2.9	36.3
Physalis viscosa	0.5	1.3	5.0	0.3	0.2	1.2	1.7
Lindheimera texana	0.3	0.6	2.5	0.1	0.1	0.6	0.8
Krameria lanceolata	0.3	0.6	2.5	0.1	0.1	0.6	0.8
Dichondra recurvata	0.3	0.6	2.5	0.1	0.1	0.6	0.8
Stellaria media	7.5	8.8	22.5	4.2	1.6	5.2	11.0
Urtica chamaedryoides	5.0	21.3	25.0	2.8	3.8	5.8	12.4

APPENDIX E (continued)

Study area Riparian forest	Parameters						
Species	Density	Dominance	% freq.	Relat. den.	Relat. dom.	Relat. freq.	Import. val.
Euphorbia spathulata	1.0	1.9	7.5	0.6	0.3	1.7	2.6
Oxalis dillenii	0.3	0.6	2.5	0.1	0.1	0.6	0.8
Celtis laevigata	0.5	4.4	5.0	0.3	0.8	1.2	2.3
Vernonia baldwinii	1.5	3.1	12.5	0.8	0.6	2.9	4.3
Helenium sp.	0.3	3.8	2.5	0.1	0.7	0.6	1.4
Tragia macrocarpa	0.3	0.6	2.5	0.1	0.1	0.6	0.8
Viola missouriensis	0.3	0.6	2.5	0.1	0.1	0.6	0.8
Allium drummondii	0.5	1.3	5.0	0.3	0.2	1.2	1.7
Lamium amplexicauli	0.5	1.3	5.0	0.3	0.2	1.2	1.7
Unknown Forbs	6.3	7.5	30.0	3.5	1.3	7.0	11.8

APPENDIX E (continued)

Study area Mesquite Woodland	Parameters						
Species	Density	Dominance	% freq.	Relat. den.	Relat. dom.	Relat. freq.	Import. val.
SHRUBS							
Prosopis glandulosa	2,142.0	22,300.0	100.0	100.0	100.0	100.0	300.0
SUMMER 1980							
Herbaceous							
Bouteloua rigidiseta	18.8	73.1	55.0	59.5	62.3	35.5	157.5
Xanthocephalum dracunculoides	6.8	10.0	27.5	21.4	8.5	17.7	47.7
Stipa leucothricha	1.9	12.5	37.5	5.9	10.7	24.2	40.8
Chloris verticillata	2.4	13.7	17.5	7.7	11.8	11.3	30.7
Eragrostis curvula	0.3	0.6	2.5	0.8	0.5	1.6	2.9
Prosopis glandulosa	0.5	4.4	5.0	1.6	3.7	3.2	8.5
Dichanthelium oligosanthes	0.3	0.6	2.5	0.8	0.5	1.6	2.9
Ambrosia psilostachya	0.5	1.3	5.0	0.8	1.1	3.2	5.1
Croton capitatus	0.3	0.6	2.5	0.8	0.5	1.6	2.9
FALL 1980							
Herbaceous							
Stipa leucotricha	36.5	94.4	82.5	14.8	47.3	34.7	96.9
Dichanthelium oligosanthes	1.5	2.5	10.0	0.6	1.3	4.2	6.1
Xanthocephalum dracunculoides	0.5	0.3	2.5	0.2	0.3	1.0	1.6
Eragrostis trichodes	3.5	10.6	17.5	1.4	5.3	7.4	14.1
Chloris verticillata	1.3	3.1	12.5	0.5	1.6	5.3	7.3
Bromus tectorum	162.3	33.7	27.5	66.0	16.9	11.6	94.5
Sporobolus cryptandrus	5.5	25.6	7.5	2.2	12.9	3.2	18.2
Aristida sp.	8.8	11.9	22.5	3.6	5.9	9.5	18.9
Bouteloua rigidiseta	0.8	1.9	7.5	0.3	0.9	3.2	4.4

APPENDIX E (continued)

Study area Mesquite Woodland	Parameters						
Species	Density	Dominance	% freq.	Relat. den.	Relat. dom.	Relat. freq.	Import. val.
Paspalum setaceum	1.0	5.0	7.5	0.4	2.5	3.2	6.1
Krameria lanceolata	0.3	0.3	2.5	0.1	0.3	1.1	1.5
Sonchus asper	16.0	5.6	22.5	6.5	2.8	9.5	18.8
Unknown Forbs	8.3	3.4	15.0	3.3	1.9	6.3	11.5
WINTER 1981							
Herbaceous							
Bromus tectorum	1,010.5	121.2	55.0	74.0	33.3	9.8	117.1
Chaerophyllum tainturieri	24.0	10.0	40.0	1.8	2.7	7.1	21.6
Valerianella radiata	12.5	7.5	30.0	0.9	2.1	5.4	8.3
Galium aparine	29.8	11.9	47.5	2.2	3.3	8.5	13.9
Stipa leucotricha	34.5	63.1	67.5	2.5	17.3	12.1	31.9
Oxalis dillenii	5.8	8.1	32.5	0.4	2.2	5.8	8.4
Evax verna	5.8	1.9	7.5	0.6	0.5	1.3	2.5
Chloris verticillata	0.8	4.4	5.0	0.1	1.2	0.9	2.1
Croton capitatus	7.5	3.8	15.0	0.6	1.0	2.7	4.3
Bromus japonicus	114.0	12.5	15.0	8.4	3.4	2.7	14.5
Cirsium horridulum	0.8	15.6	2.5	0.1	4.3	0.4	4.8
Plantago	36.5	5.0	20.0	2.7	1.4	3.6	7.6
Dichanthelium oligosanthes	1.8	3.1	12.5	0.1	0.9	2.2	3.2
Indigofera miniata	0.8	0.6	2.5	0.1	0.2	0.4	0.7
Aristida sp.	1.3	0.6	2.5	0.1	0.2	0.4	0.7
Sonchus asper	8.8	7.5	30.0	0.6	2.1	5.4	8.1
UIF 13243	40.8	23.1	67.5	3.0	6.3	12.1	21.4
Unknown Forbs	12.3	8.7	35.0	0.6	2.4	6.2	9.2

APPENDIX E (continued)

Study area Mesquite Woodland	Parameters						
Species	Density	Dominance	% freq.	Relat. den.	Relat. dom.	Relat. freq.	Import. val.
SPRING 1981							
Herbaceous							
Schedonnardus paniculatus	5.8	28.8	30.0	1.3	7.0	4.2	12.6
Galium aparine	24.0	13.1	27.5	5.5	3.2	3.9	12.6
Stipa leucotricha	24.5	63.1	72.5	5.7	15.4	10.2	31.3
Gaura coccinea	22.0	18.8	62.5	5.0	4.6	8.8	18.4
Plantago sp.	75.3	76.9	87.5	17.4	18.8	12.4	48.6
Croton capitatus	0.8	1.3	5.0	0.2	0.3	0.7	1.2
Sonchus asper	3.8	19.4	27.5	0.9	4.7	3.9	9.5
Dichanthelium oligosanthes	1.5	5.6	10.0	0.3	1.4	1.4	3.1
Oxalis dillenii	10.5	16.9	12.5	2.4	4.1	6.0	12.5
Daucus pusillus	23.8	10.0	27.5	5.5	2.4	3.9	11.8
Triodanis perfoliata	10.8	9.4	6.9	2.5	2.3	2.1	6.9
Schizachyrium scoparium	0.5	3.8	2.5	0.1	0.9	0.4	1.4
Chaerophyllum tainturieri	2.8	1.9	7.5	0.6	0.5	1.1	2.2
Bromus unioloides	0.8	0.6	2.5	0.2	0.2	0.4	0.8
Schrankia uncinata	0.3	3.8	2.5	0.1	0.9	0.4	1.4
Oenothera lacinata	0.5	1.3	5.0	0.1	0.3	0.7	1.2
Lepidium vriginicum	3.0	3.8	15.0	0.7	0.9	2.1	3.7
Sisyrinchium sp.	0.3	0.6	2.5	0.1	0.2	0.4	0.7
Bothriochloa sacchariodes	0.5	3.8	2.5	0.1	0.9	0.4	1.4
Hymenoxys scaposa	0.5	0.6	2.5	0.1	0.2	0.4	0.7
Evax verna	22.0	9.4	37.5	5.1	2.3	5.3	12.7
Verbena halei	2.5	5.0	7.5	0.6	1.2	1.1	2.9
Euphorbia spathulata	11.3	11.3	37.5	2.6	2.7	5.3	10.6
Limnodea arkansana	7.0	5.6	22.5	1.6	1.4	3.2	6.2
Vulpia octoflora	4.3	1.3	5.0	1.0	0.3	0.7	2.0

APPENDIX E (continued)

Study area Mesquite Woodland	Parameters						
Species	Density	Dominance	% freq.	Relat. den.	Relat. dom.	Relat. freq.	Import. val.
Paspalum setaceum	2.5	3.1	12.5	0.6	0.8	1.8	3.2
Bromus tectorum	110.5	38.8	22.5	25.5	9.5	3.2	38.2
Hordeum pusillum	14.3	11.3	22.5	3.3	2.7	3.2	9.2
Valerinella radiata	2.3	1.3	5.0	0.5	0.3	0.7	1.5
Bouteloua rigidiseta	0.8	1.3	5.0	0.2	0.3	0.7	1.2
Vicia dasycarpa	1.3	1.3	5.0	0.3	0.3	0.7	1.3
Aristida sp.	1.0	11.3	7.5	0.2	2.7	1.0	3.9
Ambrosia psilostachya	11.0	5.0	20.0	2.5	1.2	2.8	5.5
Physalis viscosa	0.2	3.8	2.5	0.1	0.9	0.4	1.4
Gaura coccinea	0.3	0.6	2.5	0.1	0.2	0.4	0.7
Lamium amplexicaule	0.3	0.6	2.5	0.1	0.2	0.4	0.7
Verbena bipinnatifida	0.5	4.4	5.0	0.1	1.0	0.7	1.8
Krigia occidentalis	6.0	8.8	22.5	1.4	2.1	3.2	6.7
Unknown Forbs	1.5	2.5	12.5	0.3	0.6	1.8	2.7

APPENDIX E (continued)

Study area Pecan parkland	Parameters						
Species	Density	Dominance	% freq.	Relat. den.	Relat. dom.	Relat. freq.	Import. val.
OVERSTORY							
Carya illinoinensis	45.0	4,631.2	100.0	75.0	82.8	63.5	221.3
Ulmus rubra	2.0	107.5	5.0	3.3	1.9	3.2	8.4
Fraxinus pensylvanica	2.2	537.1	20.0	3.6	9.6	12.7	25.9
Maclura pomifera	4.7	56.3	17.5	7.8	1.0	11.1	19.9
Gleditsia tricanthos	4.2	82.6	10.0	7.0	1.5	6.4	14.9
Acer negundo	2.0	180.0	5.0	3.3	3.2	3.2	9.7
UNDERSTORY							
Fraxinus pensylvanica	2.0	18.0	5.0	4.2	1.6	4.3	10.1
Maclura pomifera	5.4	80.0	12.5	11.4	7.2	10.6	29.2
Cornus drummondii	2.3	19.6	5.0	4.8	1.8	4.3	10.9
Ilex decidua	8.6	83.3	20.0	18.1	7.5	17.0	42.6
Ulmus rubra	1.1	11.1	2.5	2.4	1.0	2.1	5.5
Gleditsia triacanthos	2.5	28.5	12.5	5.2	2.7	10.6	18.5
Celtis laevigata	6.1	86.0	15.0	12.9	7.8	12.8	33.5
Carya illinoinensis	6.2	185.3	15.0	13.2	16.7	12.8	42.7
Ulmus crassifolia	7.7	508.0	17.5	16.3	45.9	14.9	77.1
Bumelia lanuginosa	2.2	32.1	5.0	4.7	2.9	4.3	11.9
Carya texana	2.1	44.7	5.0	4.4	4.0	4.3	12.7
Crataegus spathulata	1.1	11.3	2.5	2.4	1.0	2.1	5.5
SHRUBS							
Smilax bona-nox	23,884.7	49,384.6	100.0	87.6	71.5	53.3	212.4
Symphoricarpos orbiculatus	1,112.1	12,626.4	30.0	4.1	18.3	16.0	38.4
Ulmus crassifolia	1,086.5	1,401.4	17.5	4.0	2.0	9.3	15.3

APPENDIX E (continued)

Study area Pecan parkland	Parameters						
Species	Density	Dominance	% freq.	Relat. den.	Relat. dom.	Relat. freq.	Import. val.
<u>Bumelia lanuginosa</u>	318.2	318.2	10.0	1.2	0.5	5.3	7.0
<u>Gleditsia triacanthos</u>	157.5	314.9	10.0	0.6	0.5	5.3	6.4
<u>Maclura pomifera</u>	551.0	1,102.0	10.0	2.0	1.6	5.3	8.9
<u>Ilex decidua</u>	157.5	3,936.8	10.0	0.6	5.7	5.3	11.6
SUMMER 1980							
Herbaceous							
<u>Carex reniformis</u>	25.3	155.6	72.5	31.5	24.6	19.2	75.3
<u>Rubus aborigimun</u>	4.3	14.4	32.5	5.3	2.3	8.6	16.2
<u>Elymus canadensis</u>	1.5	5.6	10.0	1.9	0.9	2.7	5.5
<u>Vernonina baldwinii</u>	1.0	5.6	10.0	1.2	0.9	2.7	4.8
<u>Eragrostis</u> sp.	0.8	1.3	5.0	0.9	0.2	1.3	2.4
<u>Parthenocissus quinquefolia</u>	0.3	0.6	2.5	0.3	0.1	0.7	1.1
<u>Potentilla</u> sp.	0.3	0.6	2.5	0.3	0.1	0.7	1.1
<u>Tragia macrocarpa</u>	0.3	0.6	2.5	0.3	0.1	0.7	1.1
<u>Paspalum dilatatum</u>	2.0	13.1	15.0	2.5	2.1	4.0	8.6
<u>Dichanthelium oligosanthes</u>	7.0	28.8	42.5	8.7	4.5	11.3	24.5
<u>Cynodon dactylon</u>	20.0	303.1	52.5	25.2	47.9	13.9	87.0
<u>Dichondra recurvata</u>	4.0	9.4	25.0	5.0	1.5	6.6	13.1
<u>Smilax bona-nox</u>	9.5	78.8	67.5	11.8	12.4	17.9	42.1
<u>Rhus toxicodendron</u>	0.5	1.3	5.0	0.6	0.2	1.3	2.1
<u>Oxalis dillenii</u>	0.3	0.6	2.5	0.3	0.1	0.7	1.1
<u>Cnidoscolus texanus</u>	0.3	0.6	2.5	0.3	0.1	0.7	1.1
<u>Paspalum setaceum</u>	0.5	4.4	5.0	0.6	0.7	1.3	2.6
<u>Celtis reticulata</u>	0.5	1.3	5.0	0.6	0.2	1.3	2.1
<u>Croton capitatus</u>	0.8	1.3	5.0	0.9	0.2	1.3	2.4
<u>Symphoricarpos orbiculatus</u>	0.5	1.3	5.0	0.6	0.2	1.3	2.1

APPENDIX E (continued)

Study area Pecan parkland	Parameters						
Species	Density	Dominance	% freq.	Relat. den.	Relat. dom.	Relat. freq.	Import. val.
Ilex decidua	0.3	0.6	2.5	0.3	0.1	0.7	1.1
Ulmus crassifolia	0.5	4.4	5.0	0.6	0.7	1.3	2.6
FALL 1980							
Herbaceous							
Carex reniformis	42.0	207.0	90.0	20.1	36.0	20.3	76.4
Dichondra recurvata	57.3	50.0	42.5	27.4	8.7	9.6	45.7
Tragia macrocarpa	1.8	4.3	17.5	0.8	0.8	4.0	5.6
Rubus aboriginum	3.8	38.1	25.0	1.8	6.6	5.7	14.1
Elymus canadensis	9.8	55.0	27.5	4.7	9.6	6.2	20.5
Vernonia baldwinii	0.3	0.6	2.5	0.1	0.1	0.6	0.8
Viola missouriensis	2.3	7.5	17.5	1.1	1.3	4.0	6.4
Oxalis dillenii	1.3	3.1	12.5	0.6	0.5	2.8	3.9
Smilax bona-nox	6.5	61.9	50.0	3.1	10.7	11.2	25.0
Galium aparine	2.5	1.9	7.5	1.2	0.3	1.7	3.2
Sporobolus cryptandrus	0.5	7.5	5.0	0.2	1.3	1.1	2.6
Cynodon dactylon	6.8	26.3	20.0	3.2	4.6	4.5	12.3
Bromus tectorum	51.0	9.4	15.0	24.4	1.6	3.4	29.4
Stipa leucotricha	12.0	67.5	42.5	5.7	11.7	9.6	27.0
Symphoricarpos orbiculatus	0.3	0.6	2.5	0.1	0.1	0.6	0.8
Ulmus crassifolia	1.3	8.8	10.0	0.6	1.5	2.3	4.4
Dichanthelium oligosanthes	0.8	3.8	2.5	0.4	0.7	0.6	1.7
Paspalum dilatatum	0.8	1.9	7.5	0.4	0.3	1.7	2.4
Bumelia lanuginosa	0.3	3.8	2.5	0.1	0.7	0.6	1.4
Geranium carolinianum	2.5	0.6	2.5	1.2	0.1	0.6	1.9
UIF 15112	3.3	11.9	22.5	1.6	2.1	5.1	8.8
Unknown Forbs	4.8	5.0	20.0	2.3	0.8	4.5	7.6

APPENDIX E (continued)

Study area Pecan parkland	Parameters						
Species	Density	Dominance	% freq.	Relat. den.	Relat. dom.	Relat. freq.	Import. val.
WINTER 1981							
Herbaceous							
Carex reniformis	35.5	126.3	72.5	23.6	37.7	14.4	75.7
Elymus canadensis	14.3	38.1	40.0	9.5	11.4	7.9	28.8
Smilax bona-nox	4.0	18.1	35.0	2.7	5.4	6.9	15.0
Bromus tectorum	1.3	1.3	5.0	0.8	0.4	1.0	2.2
Dichondra recurvata	28.3	36.9	50.0	18.8	11.0	9.9	39.7
Viola missouriensis	4.0	6.3	25.0	2.7	1.9	5.0	9.6
Lamium amplexicauli	1.3	2.5	7.5	0.8	0.7	1.5	3.0
Sporobolus sp.	0.3	0.6	2.5	0.2	0.2	0.5	0.9
Geranium carolinianum	4.8	7.5	30.0	3.2	2.2	5.9	11.3
Galium aparine	18.8	16.8	55.0	12.5	5.0	10.9	28.4
Allium drummondii	0.5	0.6	2.5	0.3	0.2	0.5	1.0
Rubus aboriginum	2.3	10.6	17.5	1.5	3.2	3.5	8.2
Paspalum sp.	0.5	0.6	2.5	0.3	0.2	0.5	1.0
Symphoricarpos orbiculatus	0.5	4.4	5.0	0.3	1.3	1.0	2.6
Chaerophyllum tainturieri	6.8	6.9	27.5	4.5	2.1	5.4	12.0
Callirhoe digitata	0.3	0.6	2.5	0.2	0.2	0.5	0.9
Oxalis dillenii	2.3	6.9	15.0	1.5	2.1	3.0	6.6
Anenome heterophylla	3.8	7.5	30.0	2.5	2.2	5.9	10.6
Vicia dasycarpa	7.0	13.8	17.5	4.7	4.1	3.4	12.2
Geum canadense	0.8	4.4	5.0	0.5	1.3	1.0	2.8
UIF 13243	2.5	6.3	12.5	1.7	1.9	2.5	6.1
Aster lateriflorus	9.8	26.9	32.5	6.5	8.0	6.4	20.9
Unknown Forbs	2.0	6.9	15.0	1.3	2.0	3.0	6.3

APPENDIX B (continued)

Study area Pecan parkland	Parameters						
Species	Density	Dominance	% freq.	Relat. den.	Relat. dom.	Relat. freq.	Import. val.
SPRING 1981							
Herbaceous							
Oxalis dillenii	5.5	20.0	30.0	3.1	3.4	4.1	10.6
Elymus canadensis	18.5	37.5	62.5	10.1	6.4	8.6	25.1
Carex reniformis	42.0	94.4	80.0	23.3	16.1	11.0	50.4
Galium aparine	9.0	15.6	37.5	5.0	2.7	5.1	12.8
Chaerophyllum tainturieri	2.5	5.6	22.5	1.4	1.0	3.1	5.5
Dichanthelium oligosanthes	2.5	13.1	15.0	1.4	2.2	2.1	5.7
Vernonia baldwinii	3.3	38.8	20.0	1.8	6.6	2.8	11.2
Rubus aboriginum	4.8	23.8	32.5	2.6	4.0	4.5	11.1
Viola missouriensis	9.8	47.5	42.5	5.4	8.1	5.8	19.3
Oenothera speciosa	0.5	1.2	5.0	0.3	0.2	0.7	1.2
Stipa leucotricha	2.5	13.8	17.5	1.4	2.3	2.4	6.1
Ulmus crassifolia	1.3	3.1	12.5	0.7	0.5	1.7	2.9
Parthenocissus quinquefolia	1.8	5.6	10.0	1.0	1.0	1.4	3.4
Sisyrinchium sp.	0.3	0.6	2.5	0.1	0.1	0.3	0.5
Geranium carolinianum	2.0	4.4	17.5	1.1	0.7	2.4	4.2
Callirhoe digitata	0.5	4.4	2.5	0.1	0.1	0.3	0.5
Rhus toxicodendron	0.3	0.6	2.5	0.1	0.1	0.3	0.5
Physalis viscosa	0.3	0.6	2.5	0.1	0.1	0.3	0.5
Paspalum setaceum	0.3	0.6	2.5	0.1	0.1	0.3	0.5
Symphoricarpos orbiculatus	0.5	13.1	5.0	0.3	2.2	0.7	3.2
Hordeum pusillum	0.3	0.6	2.5	0.1	0.1	0.3	0.5
Bromus unioloides	0.5	1.3	5.0	0.3	0.2	0.7	1.2
Tragia macrocarpa	3.3	10.0	27.5	1.8	1.7	3.8	7.3
Smilax bona-nox	4.8	28.1	37.5	2.6	4.8	5.1	12.5
Dichondra recurvata	7.8	23.1	30.0	4.3	3.9	4.1	12.3

APPENDIX E (continued)

Study area Pecan parkland	Parameters						
Species	Density	Dominance	% freq.	Relat. den.	Relat. dom.	Relat. freq.	Import. val.
Plantago sp.	0.8	1.9	7.5	0.4	0.3	1.0	1.7
Helenium sp.	0.3	0.6	2.5	0.1	0.1	0.3	0.5
Anenome heterophylla	2.0	3.8	15.0	1.1	0.6	2.1	3.0
Bromus tectorum	14.8	5.6	10.0	8.2	1.0	1.4	10.6
Cirsium horridulum	0.3	3.8	2.5	0.1	0.6	0.3	1.0
Cynodon dactylon	13.0	82.5	32.5	7.2	14.0	4.5	25.7
Vicia dasycarpa	3.8	26.9	22.5	2.1	4.6	3.1	9.8
Cornus drummondii	0.3	0.6	2.5	0.1	0.1	0.3	0.5
Medicago sativa	0.3	0.6	2.5	0.1	0.1	0.3	0.5
Ruellia sp.	0.5	0.6	2.5	0.3	0.1	0.3	0.7
Celtis laevigata	0.8	8.1	7.5	0.4	1.4	1.0	2.8
Ilex decidua	0.3	0.6	2.5	0.1	0.1	0.3	0.5
Croton capitatus	6.5	6.3	12.5	3.6	1.1	1.7	6.4
Valerinellia radiata	0.3	0.6	2.5	0.1	0.1	0.3	0.5
Lamium amplexicauli	0.3	0.6	2.5	0.1	0.1	0.3	0.5
Aster lateriflorus	5.8	12.5	25.0	3.2	2.1	3.4	8.7
Unknown Forbs	6.8	24.4	47.5	4.7	4.1	6.5	15.3

APPENDIX E (continued)

Study area Oldfield	Parameters						
Species	Density	Dominance	% freq.	Relat. den.	Relat. dom.	Relat. freq.	Import. val.
SUMMER 1980							
Herbaceous							
<u>Pyrrhopappus multicaulis</u>	12.5	51.9	67.5	33.1	29.4	39.7	102.2
<u>Lygodesmia juncea</u>	24.0	118.1	90.0	63.3	67.0	52.9	183.2
<u>Helianthus annus</u>	0.5	1.3	5.0	1.3	0.7	2.9	4.9
<u>Aster</u> sp.	0.3	0.6	2.5	0.7	0.4	1.5	2.6
<u>Sorghum halepense</u>	0.3	0.6	2.5	0.7	0.4	1.5	2.6
<u>Convolvulus arvensis</u>	0.3	3.8	2.5	0.7	0.4	1.5	2.6
FALL 1980							
Herbaceous							
<u>Lamium amplexicauli</u>	55.5	55.5	100.0	100.0	100.0	100.0	300.0
WINTER 1981							
Herbaceous							
<u>Sonchus asper</u>	2.0	2.5	10.0	3.6	6.5	6.5	16.6
<u>Pyrrhopappus multicaulis</u>	7.5	11.3	45.0	13.4	29.0	29.0	71.4
<u>Lamium amplexicauli</u>	39.5	21.3	85.0	70.5	54.8	54.8	180.1
<u>Cirsium horridulum</u>	0.5	1.3	5.0	0.9	3.2	3.2	7.3
<u>Chaerophyllum tainturieri</u>	2.0	2.5	10.0	3.6	6.5	6.5	16.6
SPRING 1981							
Herbaceous							
<u>Solidago altissima</u>	11.0	36.3	57.5	19.0	16.6	21.7	57.3
<u>Pyrrhopappus maulticaulis</u>	13.8	91.9	82.5	23.8	42.0	31.1	96.9
<u>Sonchus asper</u>	8.3	46.9	55.0	14.3	21.4	20.8	56.5

APPENDIX E (continued)

Study area Oldfield	Parameters						
Species	Density	Dominance	% freq.	Relat. den.	Relat. dom.	Relat. freq.	Import. val.
Chaerophyllum tainturieri	2.0	11.9	10.0	3.5	5.4	3.8	12.7
Lamium amplexicauli	16.3	13.1	40.0	28.1	6.0	15.1	49.2
Bromus japonicus	0.3	0.6	2.5	0.4	0.3	0.9	1.6
Gaillardia sp.	0.5	4.4	5.0	0.9	2.0	1.9	4.8
Convolvulus arvensis	0.3	9.4	2.5	0.4	4.3	0.9	5.6
Solanum rostratum	0.3	0.6	2.5	0.4	0.3	0.9	1.6
Sorghum halepense	0.8	3.8	7.5	1.3	1.7	2.8	5.8

Appendix F. Size class ranking of tree species for grid T 1-2 (Mesquite/cedar elm parkland) 1980-81.

T 1-2 Species	Size Classes in cm Based on Basal Circumference Measurements													% Composition
	1 to 15	16 to 30	31 to 45	46 to 60	61 to 75	76 to 90	91 to 105	106 to 120	121 to 135	136 to 150	151 to 165	166 to 180	>180	
Ulmus crassifolia	22	9	3	4										40.8
Prosopis glandulosa	6	17	3	1		1								30.1
Celtis laevigata	3	1												4.3
Quercus stellata	7													8.6
Celtis reticulata	5													5.4
Carya texana	2													2.1
Crataegus sp.	2													2.1
Bumelia lanuginosa	1													1.1
Quercus marilandica	2													2.1
Zanthoxylum clava-herculis	3													3.2

Appendix F. Size class ranking of tree species for grid T 1-5 (Cedar elm woodland) 1980-81.

T 1-5 Species	Size Classes in cm Based on Basal Circumference Measurements													% Composition
	1 to 15	16 to 30	31 to 45	46 to 60	61 to 75	76 to 90	91 to 105	106 to 120	121 to 135	136 to 150	151 to 165	166 to 180	> 180	
Maclura pomifera		1	1	2	2	1	1							9.3
Crataegus sp.	2													2.3
Ulmus crassifolia	8		4	2	1	8	13	2		1				45.3
Celtis reticulata	17	1												20.9
Sapindus drummondii	1													1.1
Quercus macrocarpa							1							1.1
Celtis laevigata	3									1				4.6
Fraxinus texensis	1													1.1
Carya texana	2													2.3

Appendix F. Size class ranking of tree species for grid T 1-6 (Mesquite/cedar elm parkland) 1980-81.

T 1-6 Species	Size Classes in cm Based on Basal Circumference Measurements													% Composition
	1 to 15	16 to 30	31 to 45	46 to 60	61 to 75	76 to 90	91 to 105	106 to 120	121 to 135	136 to 150	151 to 165	166 to 180	>180	
Prosopis glandulosa	1	5			1									8.0
Ulmus crassifolia	9	9	5	7	1	1	9						1	47.1
Celtis reticulata	3													3.4
Gleditsia triacanthos	3													3.4
Bumelia lanuginosa	4	1												5.7
Sapindus drummondii	5	1												6.9
Ilex decidua	1													1.1
Crataegus sp.	7	4												12.6
Celtis laevigata							1							1.1
Quercus stellata	2			1			2			1				6.9
Juniperus virginiana		1												1.1
Fraxinus texensis	1													1.1

Appendix F. Size class ranking of tree species for grid T 2-2 (riparian woodland) 1980-81.

T 2-2 Species	Size Classes in cm Based on Basal Circumference Measurements													% Composition
	1 to 15	16 to 30	31 to 45	46 to 60	61 to 75	76 to 90	91 to 105	106 to 120	121 to 135	136 to 150	151 to 165	166 to 180	> 180	
Ulmus crassifolia	3	1		1	1	7	5		2	1		2	2	26.0
Sapindus drummondii	34	1	1	2										39.6
Fraxinus texensis	4	2					2							8.3
Celtis laevigata	13									1				14.5
Bumelia lanuginosa	4													4.1
Maclura pomifera			1											1.0
Morus rubra	2		1											3.1
Acer negundo		1			1									2.1
Gleditsia triacanthos	1													1.0

Appendix F. Size class ranking of tree species for grid T 3-2 (pecan parkland) 1980-81.

T 3-2 Species	Size Classes in cm Based on Basal Circumference Measurements: 1 to 15	16 to 30	31 to 45	46 to 60	61 to 75	76 to 90	91 to 105	106 to 120	121 to 135	136 to 150	151 to 165	166 to 180	> 180	% Composition
Carya illinoiensis	1	1	4	3	2	2	5	1		3			14	50.0
Fraxinus texensis	1													1.4
Maclura pomifera	8	2	1	1	1									18.0
Cornus drummondii	2													2.7
Ilex decidua	2	3												6.9
Acer negundo		1												1.4
Ulmus crassifolia	3	3												8.3
Gleditsia triacanthos	2													2.7
Celtis reticulata	5	1												8.3

Appendix F. Size class ranking of tree species for grid T 4-2 (riparian woodland) 1980-81.

	Size Classes in cm Based on Basal Circumference Measurements													
T 4-2 Species	1 to 15	16 to 30	31 to 45	46 to 60	61 to 75	76 to 90	91 to 105	106 to 120	121 to 135	136 to 150	151 to 165	166 to 180	>180	$\bar{x}$ % Composition
Quercus virginiana	2				1	1	2					1	2	10.5
Ulmus crassifolia	7	8	2	5	6	4	2							40.7
Fraxinus texensis	28		1	3										37.2
Juniperus virginiana		1												1.2
Celtis reticulata	1													1.2
Bumelia lanuginosa	3													3.5
Sapindus drummondii		1	1											2.3
Morus rubra	1													1.2
Crataegus sp.	2													2.3

QUARTERS

1

	RW	PT	PW
CR	.971	.900	.934
PW	.947	.876	
PT	.920		

2

	RW	PT	PW
CR	.915	.901	.940
PW	.939	.915	
PT	.955		

3

	RW	PT	PW
CR	.939	.883	.917
PW	.936	.894	
PT	.817		

4

	RW	PT	PW
CR	.892	.783	.768
PW	.876	.878	
PT	.920		

HABITAT TYPE

Cropland

	4	3	2
1	.844	.812	.935
2	.867	.880	
3	.880		

Parkland/Woodland

	4	3	2
1	.939	.767	.922
2	.938	.858	
3	.834		

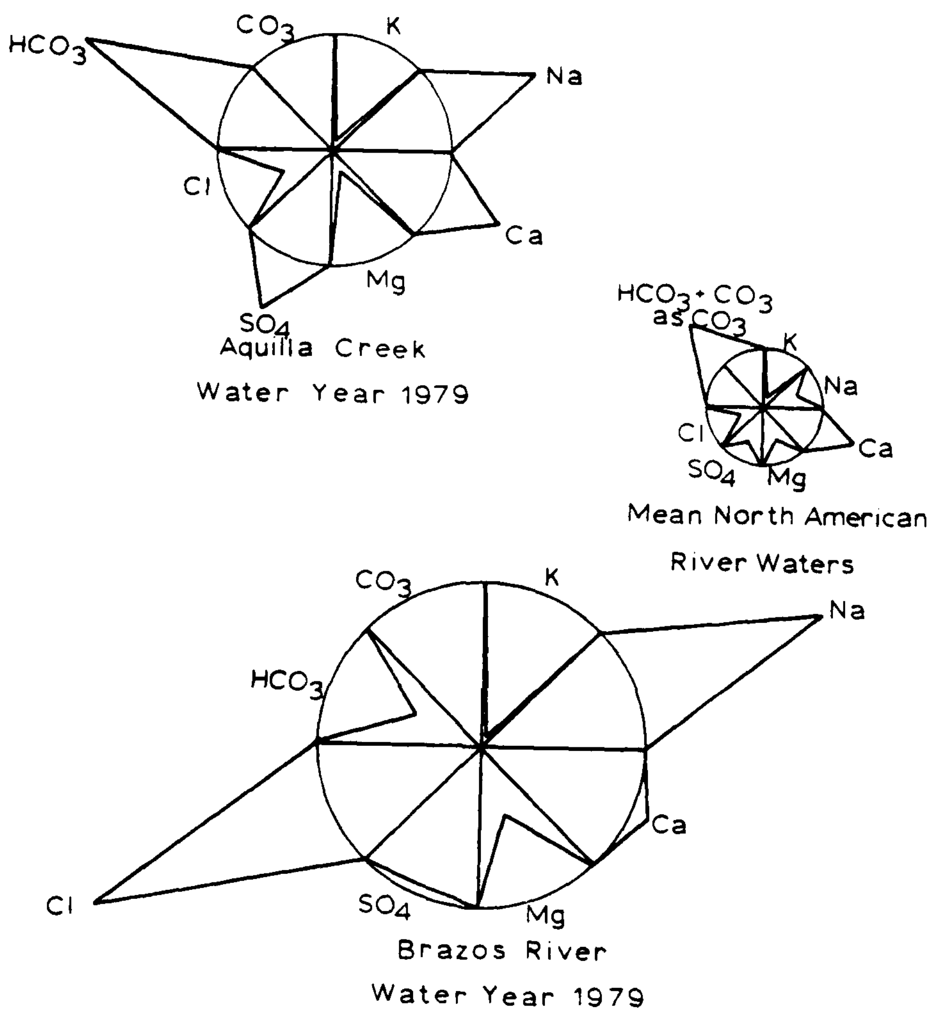
Pasture

	4	3	2
1	.831	.662	.844
2	.861	.809	
3	.841		

Riparian Woodland

	4	3	2
1	.771	.820	.930
2	.874	.926	
3	.802		

Appendix G. R_0 similarity indices for small mammals by quarter (1, 2, 3, & 4) and habitat type (1980-81). CR = Cropland, PW = Parkland/Woodland, PT = Pasture, and RW = Riparian woodland.



Appendix H. Modified Maucha diagrams comparing Aquilla with the Brazos and mean North American river waters for 1979.

Appendix I. Checklist of aquatic organisms found in Aquilla, Hackberry, and Cobb Creeks during 1980 (following Pennak).

<u>Phyla</u>

- Protozoa
  - Subphylum Ciliophora
    - Class Ciliata
      - Subclass Peritrichia
        - Family Epistylidae
          - <u>Epistylis</u>
- Coelenterata
  - Order Hydroida
    - Family Hydridae
      - <u>Hydra americana</u>
- Platyhelminthes
  - Class Turbellaria
    - Order Tricladida
      - Family Planariidae
- Rotatoria
  - Class Monogononta
    - Order Flosculariacea
      - Family Testudinellidae
        - <u>Filinia</u>
    - Order Ploima
      - Family Asplanchnidae
        - <u>Asplanchna</u>
      - Family Brachionidae
        - <u>Brachionus</u>
        - <u>Lecane</u>
        - <u>Platyias</u>
- Nematoda
- Nematomorpha (Gordiida)
- Ectoprocta (Bryozoa)
  - Class Phylactolaemata
    - Family Plumatellidae
      - <u>Plumatella</u>
- Entoprocta
  - <u>Urnatella gracilis</u>
- Annelida
  - Class Oligochaeta
  - Class Hirudinea
    - Order Rhynchobdellida
      - Family Glossiphoniidae
        - <u>Helobdella</u>
        - <u>Placobdella</u>
- Arthropoda
  - Class Crustacea
    - Subclass Branchiopida
      - Order Cladocera
        - Family Sididae
          - <u>Diaphanosoma leuchtenbergianum</u>

Appendix I. Continued.

Family Daphnidae
- *Daphnia ambigua*
- *Daphnia parvulua*
- *Simocephalus serrulatus*
- *Ceriodaphnia lacustris*
- *Ceriodaphnia reticulata*

Family Moinidae
- *Moina micrura*

Family Bosminidae
- *Bosmina longirostris*

Family Chydoridae
- *Alona verrucosa*
- *Kurzia latissima*
- *Alonella hamulatus*

Subclass Ostracoda
- Order Podocopa

Subclass Copepoda
- Order Eucopepoda
  - Suborder Calanoida
    - Family Diaptomidae
      - *Diaptomus*
  - Suborder Cyclopoida
    - Family Cyclopidae

Subclass Malacostraca
- Order Amphipoda
  - Family Talitridae
    - *Hyalella azteca*
- Order Decapoda
  - Family Astacidae

Class Insecta
- Order Ephemeroptera
  - Family Baetidae
    - *Baetis*
    - *Callibaetis*
  - Family Caenidae
    - *Caenis*
  - Family Ephemeridae
    - *Hexagenia*
  - Family Heptageniidae
    - *Stenonema*
  - Family Leptophlebiidae
    - *Leptophlebia*
- Order Odonata
  - Suborder Anisoptera
    - Family Gomphidae
      - *Erpetogomphus*
      - *Gomphus*
    - Family Libellulidae
      - *Didymops*
      - *Perithemis*
      - *Tetragoneuria*
  - Suborder Zygoptera
    - Family Coenagrionidae

Argia
Ischnura
Order Hemiptera
Family Corixidae
Family Veliidae
Family Gerridae
Gerris
Order Megaloptera
Family Corydalidae
Corydalus
Order Trichoptera
Family Hydropsychidae
Cheumatopsyche
Family Hydroptilidae
Hydroptila
Family Leptoceridae
Oecetis
Family Philopotamidae
Chimarra
Order Coleoptera
Family Dryopidae
Helichus
Family Dytiscidae
Hydroporus
Family Elmidae
Dubiraphia
Stenelmis
Family Hydrophilidae
Berosus
Helophorus
Order Diptera
Family Culicidae
Subfamily Culicinae
Subfamily Chaoborinae
Chaoborus
Family Ephydridae
Ochthera
Family Heleidae
Atrichopogon
Bezzia
Family Simuliidae
Simulium
Family Stratyomyidae
Stratyomys
Family Chironomidae
Subfamily Chironominae
Chironomus
Cladotanytarsus
Cryptochironomus
Dicrotendipes
Glyptotendipes
Harnischia
Parachironomus

Appendix I. Continued.

- *Polypedilum*
- *Rheotanytarsus*
- *Stenochironomus*
- *Stichochironomus*
- *Tanytarsus*
- *Micropsectra*
- *Zavrelia*

Subfamily Tanypodinae
- *Ablabesmyia*
- *Clinotanypus*
- *Labrundinia*
- *Procladius*
- *Tanypus*

Subfamily Orthocladiinae
- *Cricotopus*
- *Nanocladius*

Mollusca
- Class Gastropoda
  - Family Physidae
  - Family Planorbidae
- Class Pelecypoda
  - Family Unionidae
    - *Strophitus undulatus*
  - Family Sphaeridae
    - *Eupera cubensis*
    - *Sphaerium tranversum*
    - *Sphaerium partumeium*
  - Family Corbiculidae
    - *Corbicula manilensis*

Appendix J. Total benthic organisms and total numbers of taxa, by collecting date and station (1980). "NS" indicates no samples collected.

	Pools				Riffles		
	B	A	E	C	A	E	C
			Total Density #/m^2				
Mar. 5-6	2932	195916	691	426	2691	6699	4593
June 4-5	417	5683	NS	521	613	3307	915
Aug. 18-19	869	5955	2887	4616	1035	3755	927
Dec. 17-18	1186	9801	698	6362	457	4401	1860
			Number of Taxa				
Mar. 5-6	3	9	10	6	19	25	21
June 4-5	2	10	NS	5	6	15	11
Aug. 18-19	6	11	20	17	21	28	24
Dec. 17-18	5	10	12	11	9	23	19

Appendix K.

Station A, Hackberry Creek. Benthos data from quarterly collections during 1980.

Organisms	Riffles								Pools							
	March 5-6		June 4-5		Aug. 18-19		Dec. 17-18		March 5-6		June 4-5		Aug. 18-19		Dec. 17-18	
	#/m^2	(%)	#/m^2	(%)	#/m^2	(%)	#/m^2	(%)	#/m^2	(%)	#/m^2	(%)	#/m^2	(%)	#/m^2	(%)
Turbellaria - Planariidae											26	(0.5)				
Nematoda	7	(0.3)									26	(0.5)			39	(0.4)
Annelida																
Oligochaeta	1061	(39.3)	509	(83.0)	223	(21.4)	373	(81.6)	195,500	(99.8)	5370	(94.5)	3597	(60.4)	8172	(83.4)
Hirudinea - *Helobdella*					18	(1.7)	4	(0.9)					235	(3.9)	326	(3.3)
Crustacea																
Amphipoda - *Hyalella azteca*	4	(0.1)														
Decapoda - *Astacidae*									13	(0.01)						
Cladocera - *Simocephalus*															13	(0.1)
Insecta																
Emphemeroptera																
Caenidae - *Caenis*	32	(1.6)			154	(14.8)										
Baetidae - *Callibaetis*					3	(0.3)										
Odonata																
Gomphidae - *Gomphus*	4	(0.1)			11	(1.0)	4	(0.9)								
Hemiptera																
Corixidae	4	(.13)														
Trichoptera																
Hydropsychidae - *Cheumatopsyche*			18	(2.9)	3	(0.3)							12	(0.2)		
Leptoceridae - *Oecetis*					3	(0.3)										
Coleoptera																
Elmidae - *Stenelmis*	4	(0.1)			25	(2.4)	11	(2.4)								
Hydrophilidae - *Berosus*	11	(0.4)			54	(5.2)			13	(0.01)			156	(2.6)		
Dytiscidae - *Hydroporus*	4	(.13)														
Diptera																
Heleidae - *Bezzia*	4	(0.1)			3	(0.3)							39	(0.7)	78	(0.8)
Simuliidae - *Simulium*	7	(0.3)					4	(0.9)			52	(0.9)				
Ephydridae - *Ochthera*					3	(0.3)										
Chironomidae - *Polypedilum*	20	(0.7)	43	(7.0)												
- *Glyptotendipes*	20	(0.7)			18	(1.7)	7	(1.6)								
- *Dicrotendipes*	89	(3.3)			143	(13.8)							117	(2.0)		
- *Chironomus*			7	(1.1)	43	(4.1)	39	(8.5)	213	(0.1)	26	(0.5)	235	(3.9)	656	(6.7)
- *Cryptochironomus*									42	(0.02)	26	(0.5)				

Appendix K. Continued.

Station A (continued).

Organisms	Riffles March #/m²	5-6 (%)	June #/m²	4-5 (%)	Aug. #/m²	18-19 (%)	Dec. #/m²	17-18 (%)	Pools March #/m²	5-6 (%)	June #/m²	4-5 (%)	Aug. #/m²	18-19 (%)	Dec. #/m²	17-18 (%)
- <u>Cladotanytarsus</u>					14	(1.4)	4	(0.8)					1095	(18.4)		
- <u>Tanytarsus</u>													235	(3.9)	69	(0.7)
- <u>Ablabesmyia</u>	69	(2.6)			22	(2.1)					26	(0.5)				
- <u>Procladius</u>									42	(0.02)	26	(0.5)			34	(0.3)
- <u>Tanypus</u>					3	(0.3)							117	(2.0)	311	(3.2)
- <u>Clinotanypus</u>															103	(1.1)
- <u>Cricotopus</u>	644	(23.9)	25	(4.1)	14	(1.4)					79	(1.4)				
- <u>Nanocladius</u>											26	(0.5)				
- unid. Orthoclad.	595	(22.1)							42	(0.02)						
- unid.					25	(2.4)							117	(2.0)		
Gastropoda																
Physidae	18	(0.2)			89	(8.6)			26	(0.01)						
Pelecypoda																
Sphaeridae - <u>Sphaerium</u>	94	(3.5)	11	(1.8)	164	(15.9)	11	(2.4)	39	(0.02)						
# taxa	19		6		21		9		9		10		11		10	
TOTAL	2691	(100)	613	(100)	1035	(100)	457	(100)	195,916	(100)	5683	(100)	5955	(100)	9801	(100)

Appendix K. Continued.

Station B, Aquilla Creek. Benthos data from quarterly collections during 1980.

Organism	March 5-6 #/m²	(%)	June 4-5 #/m²	(%)	Aug. 18-19 #/m²	(%)	Dec. 17-18 #/m²	(%)
Annelida								
Oligochaeta	2046	(69.8)	404	(96.9)	755	(86.6)	639	(53.9)
Crustacea								
Amphipoda - _Hyalella azteca_					12	(1.5)		
Insecta								
Ephemeroptera								
Baetidae - _Caenis_					12	(1.5)		
Diptera								
Helidae - _Bezzia_							13	(1.1)
Culicidae - _Chaoborus_	782	(26.7)			66	(7.5)	495	(41.7)
Chironomidae - _Polypedilum_			13	(3.1)	12	(1.5)		
- _Chironomus_	105	(3.6)						
- _Tanypus_					12	(1.5)	26	(2.2)
Gastropoda								
Physidae							13	(1.1)
TOTAL	2932	(100)	417	(100)	869	(100)	1186	(100)
# taxa	3		2		6		5	

Appendix K. Continued.

Station C, Aquilla Creek. Benthos data from quarterly collections during 1980.

	Riffles								Pools							
	March 5-6		June 4-5		Aug. 18-19		Dec. 17-18		March 5-6		June 4-5		Aug. 18-19		Dec. 17-18	
	#/m^2	(%)	#/m^2	(%)	#/m^2	(%)	#/m^2	(%)	#/m^2	(%)	#/m^2	(%)	#/m^2	(%)	#/m^2	(%)
Turbellaria - Planariidae					11	(1.2)										
Nematoda	11	(.2)	4	(0.4)			22	(1.2)								
Annelida																
Oligochaeta	32	(.7)	57	(6.2)	89	(9.6)	315	(16.9)	207	(48.5)	261	(50.1)	2827	(61.1)	5279	(83.0)
Hirudinea - <u>Helobdella</u>	4	(.1)											12	(0.3)		
Crustacea																
Amphipoda - <u>Hyalella azteca</u>																
Cladocera - <u>Simocephalus</u>							4	(0.2)								
Insecta																
Ephemeroptera																
Caenidae - <u>Caenis</u>	47	(1.0)			14	(1.5)	7	(0.4)	51	(12.1)			559	(12.1)		
Baetidae - <u>Baetis</u>	4	(.1)			11	(1.2)							12	(0.3)		
Leptophlebiidae - <u>Leptophlebia</u>	4	(.1)														
Ephemeridae - <u>Hexagenia</u>													90	(2.0)	52	(0.8)
Heptageniidae - <u>Stenonema</u>					3	(0.4)										
Odonata																
Gomphidae - <u>Gomphus</u>	11	(.2)			3	(0.4)							27	(0.6)		
Libellulidae - unid.					3	(0.4)										
Coenagrionidae - <u>Argia</u>			4	(0.4)	22	(2.3)	7	(0.4)								
- <u>Ischnura</u>	4	(.1)			3	(0.4)										
Hemiptera																
Corixidae					3	(0.4)							12	(0.3)		
Trichoptera																
Hydropsychidae - <u>Cheumatopsyche</u>	43	(.9)	523	(57.2)							52	(10.0)				
Hydroptilidae - <u>Hydroptila</u>			90	(9.8)												
Leptoceridae - <u>Oecetis</u>					3	(0.4)							129	(2.8)		
Philopotamidae - <u>Chimarra</u>	36	(.8)														
Coleoptera																
Elmidae - <u>Stenelmis</u>	118	(2.6)	82	(9.0)	301	(32.3)	197	(10.6)			52	(10.0)			26	(0.4)
Elmidae - <u>Dubiraphia</u>							4	(0.2)					66	(1.4)	13	(0.2)

Appendix K. Continued.

Station C (continued).

	Riffles								Pools							
	March 5-6		June 4-5		Aug. 18-19		Dec. 17-18		March 5-6		June 4-5		Aug. 18-19		Dec. 17-18	
	#/m^2	(%)	#/m^2	(%)	#/m^2	(%)	#/m^2	(%)	#/m^2	(%)	#/m^2	(%)	#/m^2	(%)	#/m^2	(%)
Dryopidae - <u>Helichus</u>	4	(.1)			57	(6.2)										
Hydrophilidae - <u>Berosus</u>					89	(9.6)	14	(0.8)								
Megaloptera																
Corydalidae - <u>Corydalus</u>							4	(0.2)								
Diptera																
Heleidae - <u>Bezzia</u>					8	(0.8)									26	(0.4)
Simuliidae - <u>Simulium</u>	2551	(55.6)	4	(0.4)			412	(22.2)								
Culicidae - <u>Chaoborus</u>															39	(0.6)
Chironomidae - <u>Polypedilum</u>	553	(12.0)	111	(12.1)			25	(1.3)								
- <u>Glyptotendipes</u>	17	(0.4)														
- <u>Dicrotendipes</u>					35	(3.8)	32	(1.7)					39	(0.8)		
- <u>Chironomus</u>							4	(0.2)								
- <u>Cryptochironomus</u>					3	(0.4)			26	(6.1)	52	(10.0)	12	(0.3)	13	(0.2)
- <u>Cladotanytarsus</u>					3	(0.4)										
- <u>Tanytarsus</u>					8	(0.8)										
- <u>Rheotanytarsus</u>									103	(24.2)						
- <u>Zavrelia</u>													12	(0.3)		
- <u>Ablabesmyia</u>	17	(0.4)	25	(2.7)					13	(3.0)			118	(2.6)		
- <u>Procladius</u>					8	(0.8)										
- <u>Tanypus</u>													51	(1.1)		
- <u>Labrundinia</u>					3	(0.4)							51	(1.1)		
- <u>Cricotopus</u>	1072	(23.3)	11	(1.2)			42	(2.3)								
- <u>Nanocladius</u>							11	(0.6)								
- unid. Orthoclad.							4	(0.2)								
- unid.							18	(1.0)	26	(6.1)						
Gastropoda -																
Physidae	11	(.2)			40	(4.2)					104	(20.0)				
Planorbidae	4	(.1)													13	(0.2)
Pelecypoda																
Sphaeridae - <u>Sphaerium</u>	43	(.9)	4	(0.4)	129	(13.8)	727	(39.1)					51	(1.1)	106	(1.7)
- <u>Eupera</u>							11	(0.6)							39	(0.6)
- <u>Corbicula</u>	7	(.2)			78	(8.5)							536	(11.5)	756	(11.9)
TOTAL	4593	(100)	915	(100)	927	(100)	1860	(100)	426	(100)	521	(100)	4616	(100)	6362	(100)
# taxa	21		11		24		19		6		5		17		11	

Appendix K. Continued.

Station D, Cobb Creek. Benthos data from quarterly collections during 1980.

Organisms	March 5-6 #/m^2	March 5-6 (%)	June 4-5 #/m^2	June 4-5 (%)	Aug. 18-19 (%)	Dec. 17-18 (%)
Nematoda					(2.2)	
Annelida						
Oligochaeta	42	(20)	22	(1.5)	(65.2)	(66.7)
Crustacea						
Amphipoda - <u>Hyalella azteca</u>						(4.8)
Decapoda - <u>Astacidae</u>	8	(4)				
Ostracoda						(4.8)
Insecta						
Emphemeroptera						
Caenidae - <u>Caenis</u>	25	(12)	22	(1.5)		
Heptageniidae - <u>Stenonema</u>						(4.8)
Odonata						
Libellulidae - <u>Didymops</u>						(4.8)
Trichoptera						
Hydropsychidae - <u>Cheumatopsyche</u>			75	(5.3)	(2.2)	
Hydroptilidae - <u>Hydroptila</u>			22	(1.5)		
Philopotamidae - <u>Chimarra</u>			11	(0.8)		
Coleoptera						
Elmidae - <u>Stenelmis</u>	8	(4)				
- <u>Dubirophia</u>					(2.2)	
Diptera						
Heleidae - <u>Bezzia</u>					(4.3)	(4.8)
Simuliidae - <u>Simulium</u>	51	(24)	204	(14.4)		
Culicidae - <u>Chaoborus</u>					(2.2)	
Chironomidae -	51	(24)				
- <u>Polypedilum</u>			1064	(74.9)	(2.2)	
- <u>Chironomus</u>					(8.7)	
- <u>Stichochironomus</u>					(2.2)	
- <u>Tanytarsus</u>					(2.2)	
- <u>Procladius</u>						(9.5)
- <u>Tanypus</u>					(6.5)	
TOTAL	210	(100)	1420	(100)	(100)	(100)
# taxa	6		7		11	-

Appendix K. Continued.

Station E, Aquilla Creek. Benthos data from quarterly collections during 1980.

	Riffles								Pools						
	March 5-6 #/m²	(%)	June 4-5 #/m²	(%)	Aug. 18-19 #/m²	(%)	Dec. 17-18 #/m²	(%)	March 5-6 #/m²	(%)	June 4-5 not sampled	Aug. 18-19 #/m²	(%)	Dec. 17-18 #/m²	(%)
Turbellaria - Planariidae	276	(4.1)	143	(4.3)	8	(0.2)	416	(9.5)				25	(0.9)	12	(1.7)
Nematoda															
Annelida															
Oligochaeta	32	(0.5)	50	(1.5)	247	(6.5)	648	(14.7)	352	(50.9)		368	(12.8)	536	(76.8)
Hirudinea - Helobdella			29	(0.9)	3	(0.1)	43	(1.0)				8	(0.3)	12	(1.7)
- Placobdella					3	(0.1)									
Crustacea															
Amphipoda - Hyalella azteca	18	(0.3)			22	(0.6)	32	(0.7)				43	(1.4)		
Entoprocta - Urnatella gracilis												8	(0.3)		
Insecta															
Emphemeroptera															
Caenidae - Caenis	25	(0.4)			8	(0.2)			65	(9.4)					
Baetidae - Baetis	7	(0.1)					46	(1.0)							
- Callibaetis					3	(0.1)									
Heptageniidae - Stenonema	4	(0.1)	7	(0.2)											
Odonata															
Gomphidae - Gomphus												8	(0.3)		
- Erpetogomphus			14	(0.4)			3	(0.1)							
Libellulidae - Tetragoneuria							3	(0.1)							
- Macromia			4	(0.1)											
- unid.					3	(0.1)									
Coenagrionidae - Argia			29	(0.9)	3	(0.1)									
- Ischnura	7	(0.1)			8	(0.2)	40	(0.9)				18	(0.6)		
Trichoptera															
Hydropsychidae - Cheumatopsyche	1136	(17.0)	2175	(65.8)			18	(0.4)							
Hydroptilidae - Hydroptila					8	(0.2)									
Leptoceridae - Oecetis					3	(0.1)									
Philopotamidae - Chimarra	14	(0.2)													
Coleoptera															
Elmidae - Stenelmis	269	(4.0)	315	(9.5)	169	(4.5)	835	(19.0)	13	(1.9)		558	(19.4)	12	(1.7)
- Dubiraphia												18	(0.6)		
Dryopidae - Helichus	11	(0.2)													
Hydrophilidae - Berosus	14	(0.2)	7	(0.2)	207	(5.5)	14	(0.3)				308	(10.7)		

Appendix K. Continued.

Station E (continued).

	Riffles								Pools						
	March 5-6 #/m2	(%)	June 4-5 #/m2	(%)	Aug. 18-19 #/m2	(%)	Dec. 17-18 #/m2	(%)	March 5-6 #/m2	(%)	June 4-5 not sampled	Aug. 18-19 #/m2	(%)	Dec. 17-18 #/m2	(%)
- Helophorus					8	(0.2)									
- unid.					18	(0.5)									
unid.					8	(0.2)									
Diptera															
Heleidae - Bezzia					8	(0.2)						58	(2.0)	12	(1.7)
- Atrichopogon					3	(0.1)									
Simuliidae - Simulium	3537	(53.0)					1247	(28.3)	26	(3.8)				39	(5.6)
Culicidae - Chaoborus									26	(3.8)					
Stratyomyidae - Stratyomys					14	(0.4)									
Chironomidae - Polypedilum	330	(4.9)	186	(5.6)	3	(0.1)	103	(2.3)						13	(1.8)
- Glyptotendipes	29	(0.4)													
- Dicrotendipes	213	(3.2)			18	(0.5)	22	(0.5)	42	(6.1)		25	(0.9)	13	(1.8)
- Chironomus												8	(0.3)		
- Cryptochironomus									69	(10.0)					
- Parachironomus												8	(0.3)		
- Stenochironomus			4	(0.1)											
- Cryptotendipes					3	(0.1)									
- Cladotanytarsus									14	(2.0)					
- Tanytarsus	39	(0.6)			14	(0.4)	12	(0.3)	14	(2.0)					
- Rheotanytarsus	79	(1.2)													
- Ablabesmyia	29	(0.4)	7	(0.2)			12	(0.3)							
- Procladius									14	(2.0)		25	(0.9)	12	(1.7)
- Clinotanypus					3	(0.1)									
- Cricotopus	272	(4.1)					58	(1.3)						13	(1.8)
- Nanocladius							58	(1.3)							
- unid. Orthoclad.	184	(2.8)													
- unid.	29	(0.4)					58	(1.3)				33	(1.2)		
Gastropoda															
Physidae	4	(0.1)			25	(0.7)	14	(0.3)				75	(2.6)		
Planorbidae							14	(0.3)				225	(7.8)		
Pelecypoda															
Sphaeridae - Sphaerium	92	(1.4)	278	(8.4)	355	(9.5)	605	(13.7)				100	(3.5)	12	(1.7)
- Eupera	19	(0.3)	59	(1.8)	2580	(68.7)	100	(2.3)				968	(33.6)	12	(1.7)
TOTAL	6669	(100)	3307	(100)	3755	(100)	4401	(100)	691	(100)		2887	(100)	698	(100)
# taxa	25		15		28		23		10			20		12	

Appendix K. Continued.

Percent composition of zooplankton from selected pools on Cobb, Aquilla, and Hackberry Creeks, August 19-21, 1980. A "+" indicates an organism was present but did not occur in counts.

	Cobb	Aquilla Creek (Section and Pool No.)									Hackberry Creek (Station)					
		Sect. 1		Sect. 2	Sect. 3		Sect. 4		Sect. 5	Dam site						Dam Site
	D	1	2	4	5	6	7	8	B	Pool	1	2	3	4	A	Pool
<u>Hydra</u>																+
Nemata	+												+			
Oligochaeta	+												+			
Insecta																
<u>Chaoborus</u>		+	2.9		43.5		+				+	+				
<u>Culicinae</u>					+											0.9
Chironomidae				+	+	+							1.0			
<u>Bezzia</u>					+								+			
Protozoa-<u>Epistylis</u>													+	1.8		
Rotifera																
<u>Asplanchna</u>											+		1.0		0.8	
<u>Brachionus</u>			7.6								76.0	10.3	24.5	10.8	6.4	
<u>Filinia</u>	0.7										+			1.0		
<u>Lecane</u>			1.0											1.8	0.8	
<u>Platyias</u>	38.7			+			0.4						3.9	28.8	2.4	
unid. rotifer		+					0.4	+								
Cladocera																
<u>Alona verrucosa</u>	+	+														
<u>Bosmina longirostris</u>															0.8	
<u>Ceriodaphnia lacustris</u>						1.3	2.7		0.9	2.0					0.8	1.7
<u>Ceriodaphnia reticulata</u>										0.5				25.2		0.9
<u>Daphnia ambigua</u>							0.8		0.5							
<u>Daphnia parvula</u>									1.4	1.0					1.6	2.6
<u>Diaphanosoma leuchtenbergianum</u>		4.5	27.6		+					2.0					1.6	+
<u>Kurzia latissima</u>							+	0.7								
<u>Moina micrura</u>		+	+		+		+			1.0	+	1.7		1.0	+	
<u>Alonella hamulatus</u>										+						
<u>Simocephalus serrulatus</u>							+									
Ostracoda	1.4	2.3	3.8	2.0		55.1	+	+	0.5				5.9	11.7	6.4	+
Copepoda																
Cyclopoida	45.8	78.0	18.1	83.0	42.6	33 3	78.0	95.9	49.1	7.3	10.9	85.3	41.2	8.1	14.4	6.9
Calanoida	+	+						+	39.4	75.1	+	+	1.0	+	50.4	75.9
Copepod nauplii	12.7	15.2	39.0	15.0	13.9	10.3	17.8	3.4	8.3	11.2	13.2	2.6	21.6	9.9	13.6	11.2
TOTAL	100	100	100	100	100	100	100	100	100	100	100	100	100	100	100	100
# Organisms counted	142	132	105	100	108	78	259	148	216	205	129	116	102	111	125	116

Appendix K. Continued.

Benthos data from low water survey stations on Hackberry Creek August 19-20, 1980. The letters "P" and "R" after station designations indicate "Pool" or "Riffle" respectively. Station "A" is the regular Hackberry station used for quarterly sampling.

Organisms	1P %	2P %	2R %	3P %	4P %	4R %	4R (#/m²)	AP %	AP (#/m²)	AR %	AR (#/m²)
Planariidae						.7	(11)				
Nematomorpha (Gordiida)	1.6										
Entoprocta - Plumatella				.3							
- Urnatella gracilis					.6						
Annelida - Oligochaeta	15.6	11.1		85.6	39.9	9.7	(140)	60.4	(3597)	21.4	(223)
- Hirudinea - Helobdella				.7	.6	4.1	(59)	3.9	(235)	1.7	(18)
- Placobdella					.6	7.1	(102)				
Amphipoda - Hyalella azteca					4.0	.4	(5)				
Mollusca - Gastropoda - Physidae	1.6			1.3	20.2	3.3	(48)			8.6	(89)
- Pelecypoda - Sphaeridae - Sphaerium										15.9	(164)
Insecta - Ephemeroptera - Caenidae - Caenis				.7	6.4	29.7	(430)			14.8	(154)
- Baetidae - Callibaetis					6.4					.3	(3)
- Trichoptera - Hydropsychidae - Cheumatopsyche						.4	(5)	.2	(12)	.3	(3)
- Leptoceridae - Oecetis					.6	.4	(5)			.3	(3)
- Odonata - Libellulidae - Perithemis	4.7										
- Gomphidae - Gomphus				.3	1.7	.4	(5)			1.0	(11)
- Coenagrionidae - Ischnura						.4	(5)				
- Coleoptera - Hydrophilidae - Berosus	3.1			3.0	9.8	21.2	(306)	2.6	(156)	5.2	(54)
- Elmidae - Stenelmis					.6	1.9	(27)			2.4	(25)
- Hemiptera - Corixidae	1.6					.7	(11)				
- Veliidae						.4	(5)				
- Diptera - Culicidae - Chaoborus	3.1										
- Heleidae - Bezzia	1.6			.7	.6			.7	(39)	.3	(3)
- Ephydridae - Ochthera										.3	(3)
- Chironomidae - Tanypus	10.9		3.3	3.0	4.0			2.0	(117)	.3	(3)
- Procladius	1.6			.3							
- Labrundia					1.2						
- Ablabesmyia						.4	(5)			2.1	(22)
- Tanytarsus					.6			3.9	(235)		
- Cladotanytarsus								18.4	(1095)	1.4	(14)
- Chironomus	45.3	88.9	73.8	1.4		.7	(11)	3.9	(235)	4.1	(43)

Appendix K. Continued.

Benthos data from low water survey stations on Hackberry Creek (continued).

Organisms	1P %	2P %	2R %	3P %	4P %	4R %	4R (#/m^2)	AP %	AP (#/m^2)	AR %	AR (#/m^2)
- <u>Glyptotendipes</u>	9.4		23.0		1.2	15.6	(226)			1.7	(18)
- <u>Dicrotendipes</u>				2.4	.6	2.6	(38)	2.0	(117)	13.8	(143)
- <u>Stichochironomus</u>				.3							
- <u>Parachironomus</u>					.6						
- unid.								2.0	(117)	2.4	(25)
- <u>Cricotopus</u>										1.4	(14)
TOTAL	100	100	100	100	100	100	(1444)	100	(5955)	100	(1036)
# of organisms	64	9	1098	298	173	269		457		290	

Appendix L. Profiles of dissolved oxygen (mg/l) at the pool site on Hackberry Creek (temperature in C° in parentheses) on two dates during 1980.

Depth (m)	June 4	December 17
Surface	7.8 (28)	10.3 (13)
0.5	7.1 (28)	10.3 (11.5)
1.0		9.1 (11)

Profiles of dissolved oxygen (mg/l) at the stagnant pool on Aquilla Creek above the confluence with Hackberry Creek (temperature in C° in parentheses).

Depth (m)	June 5	August 15	December 17
Surface	4.1 (24)	5.6 (29)	0.7 (10)
0.5	3.9 (24)	3.5 (28)	0.2 (9)
1.0	2.3 (23.5)	3.5 (27.5)	0.1 (8.5)
1.5	0.7 (22.5)		

Appendix L. Continued.

Station A. Physical, chemical, and biological characteristics of surface waters of Hackberry Creek, Hill County, Texas on four dates during 1980.

	March 6	June 4	August 19	December 17
Physical Appearance	Green	Green-brown	Green-brown	Green
Current	Slow	Slow	Slow	Slow
Temperature C°	9	28	26	12
Conductivity mphos/cm	1000	770	2400	1200
pH	8.3	8.2	8.7	8.1
Dissolved Oxygen mg/1 O_2	8.3	7.8	2.0	10.3
Total Filterable Hydrolyzable Phosphorus mg/l PO_4-P	0.08	0.18	1.60	0.90
Nitrate mb/1 NO_3-N	1.3	0.7	0.06	2.1
Nitrite mg/1 NO_2-N	0.11	0.03	0.0	0.14
Ammonia mg/1 NH_3-N	0.03	0.03	0.16	0.01
Chlorophyll-a	21.5	9.31	32.35	56.75

Station B. *Physical, chemical, and biological characteristics of surface waters of Aquilla Creek above the confluence with Hackberry Creek in Hill County, Texas, on four dates during 1980.*

	March 6	June 5	August 19	December 17
Physical Appearance	Green	Green-brown	Green	Brown
Current	None	None	None	None
Temperature C°	12	24	29	11
Conductivity µmhos/cm	825	1500	1200	300
pH	7.6	7.6	7.5	7.4
Dissolved Oxygen mg/l O_2	6.7	4.1	5.6	0.7
Total Filterable Hydrolyzable Phosphorus mg/l PO_4-P	0.0	0.03	0.09	0.7
Nitrate mg/l NO_3-N	0.01	0.9	0.02	0.07
Nitrite mg/l NO_2-N	0.0	0.01	0.005	0.01
Ammonia mg/l NH_3-N	0.03	0.03	0.03	0.10
Cholorphyll-a mg/m^3	16.4	3.42	23.3	32.1

Appendix E. Continued.

Stations C & E. Physical and chemical characteristics of surface waters of Aquilla Creek below the confluence with Hackberry Creek (Station E) and Cobb Creek (Station C) in Hill County, Texas, on four dates during 1980.

	March 6		June 5		August 19		December 18	
	E	C	E	C	E	C	E	C
Physical Appearance	Turbic	Slightly Turbid	Turbid	Slightly Turbid	Turbid	Clear	Turbid-brown	Turbid
Current	Moderate	Moderate	Moderate	Moderate	Slow	Slow	Slow	Slow
Temperature C°	14	15	26	27	27	31	11	13
Conductivity umhos/cm	800	760	750	750	1200	800	680	710
pH	8.3	8.2	7.9	7.9	7.5	7.6	7.4	7.4
Dissolved Oxygen mg/1	10.0	10.0	7.6	7.6	6.8	7.2	4.4	6.6

Station D. Physical, chemical, and biological characteristics of surface waters of Cob Creek, Hill County, Texas, on four dates during 1980.

	March 5	June 4	August 18	December 18
Physical Appearance	Clear	Slightly Turbid	Slightly Turbid	Brown
Current	Moderate	Moderate	None	None
Conductivity µmhos/cm			3400	
Total Filterable Hydrolyzable Phosphorus Mg/l NO_4-N	0.02	0.03	0.09	0.07
Nitrate mg/l NO_3-N	1.4	0.9	0.08	0.01
Nitrite mg/l NO_4-N	0.05	0.01	0.01	0.00
Ammonia mg/l NH_3-N	0.01	0.01	0.02	0.01
Chlorophyll-a mg/m^3	1.4	1.01	4.47	5.18

Appendix M. Specific conductance and pH of waters of Aquilla and Hackberry Creeks during low water survey, August 20-21, 1980. "STP" means Sewage Treatment Plant at Hillsboro.

Section	Pool Number	Specific Conductance µmhos	pH
Aquilla A	1	1200	7.5
	2	1200	7.5
Aquilla B	4	1200	7.3
Aquilla C	5	1000	7.6
	6	2500	7.2
Aquilla D	7	1800	7.6
	8	1100	7.7
Aquilla E	B	1200	7.5
Dam Site	Above Confluence	1200	8.1
Hackberry	1 Above STP	2400	9.1
Hackberry	2 Below STP	2300	9.4
Hackberry	3	2400	8.8
Hackberry	4	2400	—
Hackberry	A	2400	8.7
Dam Site	Below Confluence	1200	7.9

Appendix N. (Continued)

Species	Month	Site	No. Fish	Length Range	(a)	(b)
	May	A	102	30-80	-11.977	3.168
		C	77	25-70	-11.403	2.990
		D	30	25-60	-11.016	2.901
		E	44	30-65	-11.654	3.148
	August	A	91	20-90	-12.331	3.222
		C	84	20-55	-11.228	2.966
		E	27	25-65	-9.448	2.483
	December	A	40	25-60	-10.450	2.706
		C	62	25-60	-12.407	3.222
		E	14	25-40	-13.266	3.442
Bullhead Minnow	August	A	75	25-55	-11.859	3.099
		C	62	20-65	-11.103	2.886
		E	66	15-70	-11.358	2.987
	December	A	42	30-60	-11.613	3.032
		C	59	25-60	-13.230	3.440
		E	21	20-60	-11.909	3.086

Appendix N. Lenght-weight relationships for 4 fish species, Aquilla Creek drainage, 1980. Log_e Weight (g) = a + b $\log_e$ Total length (mm).

Species	Month	Site	No. Fish	Length Range	(a)	(b)
Green Sunfish	August	B	83	40-155	-11.060	3.048
		C	21	54-130	-10.966	2.992
		D	77	40-170	-11.663	3.153
		E	14	50-90	-12.687	3.412
		F	126	40-165	-12.266	3.295
	December	A	22	65-150	-11.672	3.159
		B	12	40-150	-10.284	2.857
		C	24	55-170	-11.704	3.176
Longear Sunfish	August	A	52	15-125	-11.064	3.046
		C	78	20-125	-11.146	3.072
		D	97	20-115	-10.688	2.928
		E	86	20-120	-10.933	3.016
		F	91	25-115	-11.504	3.141
	December	A	46	35-135	-11.189	3.071
		C	58	25-135	-11.300	3.104
		D	12	35-80	-12.092	3.257
		E	19	25-130	-11.454	3.133
Red Shiner	March	A	39	30-65	-11.373	3.065
		C	178	30-50	-11.822	3.133
		D	54	25-60	-9.869	2.623
		E	107	25-60	-11.538	3.066
		F	17	35-50	-14.260	3.790

Appendix O. List of plants collected and identified on the Aquilla Lake Project, 1980-81.

Common Name	Scientific Name
Trees/shrubs	
Common Persimmon	Diospyros virginiana
Roughleaf Dogwood	Cornus drummondii
Blackjack Oak	Quercus marilandica
Boxelder	Acer negundo
Red Mulberry	Morus rubra
Western Soapberry	Sapindus drummondii
Green Ash	Fraxinus pensylvanica
Texas Redbud	Cercis canadensis
Smooth Sumac	Rhus glabra
Texas Sophora	Sophora affinis
Black Willow	Salix nigra
Pecan	Carya illinoinensis
Post Oak	Quercus stellata
Shumard Oak	Quercus shumardii
American Sycamore	Platanus occidentalis
Live Oak	Quercus virginiana
American Elm	Ulmus americana
Cedar Elm	Ulmus crassifolia
Gum Bumelia	Bumelia lanuginosa
Eastern Cottonwood	Populus deltoides
Hawthorn	Crataegus mollis
Hercules Club	Zanthoxylum clava-herculis

Appendix O (continued).

Common Name	Scientific Name
Honey Mesquite	*Prosopis glandulosa*
Eastern Redcedar	*Juniperus virginiana*
Sugarberry	*Celtis laevigata*
Osage Orange	*Maclura pomifera*
Black Hickory	*Carya texana*
Honey Locust	*Gleditsia triacanthos*
Yaupon	*Ilex vomitoria*
Trumpet Creeper	*Campsis radicans*
Net-leaf Hackberry	*Celtis reticulata*
American Beautyberry	*Callicarpa americana*
Possumhaw	*Ilex decidua*
Coralberry	*Symphoricarpos orbiculatus*
Catalpa	*Catalpa speciosa*
Tasajillo	*Opuntia leptocaulis*
Green brier	*Smilax bona-nox*
Poison Ivy	*Rhus toxicodendron*
Prickly Pear	*Opuntia phaeacantha*
White Prairie Rose	*Rosa filiolosa*
Bur Oak	*Quercus macrocarpa*
Slippery Elm	*Ulmus rubra*
Elbow-Bush	*Forestiera pubescens*
Southen Black-haw	*Virburnum rufidulum*
China-berry Tree	*Melia azedarach*
Fragrant sumac	*Rhus aromatica*

Appendix O (continued).

Common Name	Scientific Name
Grasses/sedges	
Texas Grama	*Bouteloua rigidiseta*
Sand Dropseed	*Sporobolus cryptandrus*
Wooly Dicanthelium	*Dichanthelium acuminatum*
Silver Bluestem	*Bothriochloa sacchariodes*
Red Lovegrass	*Eragrostis secundiflora*
Windmillgrass	*Chloris verticillata*
King Ranch Bluestem	*Bothriochloa ischaemum*
Texas Wintergrass	*Stipa leucotricha*
Buffalograss	*Buchloe dactyloides*
Rescuegrass	*Bromus unioloides*
White Tridens	*Tridens albescens*
Little Barley	*Hordeum pusillum*
Johnsongrass	*Sorghum halepense*
Japanese Brome	*Bromus japonicus*
Dallisgrass	*Paspalum dilatatum*
Downy Brome	*Bromus tectorum*
Scribner's Dichanthelium	*Dichanthelium oligosanthes*
Virginia Wildrye	*Elymus virginiana*
Ozarkgrass	*Limnodea arkansana*
Ryegrass	*Lolium perene*
Thin Paspalum	*Paspalum setaceum*
Little Bluestem	*Schizachyrium scoparium*
Sand Lovegrass	*Eragrostis trichodes*

Appendix O (continued).

Common Name	Scientific Name
Carolina Jointtail	*Coelorachis cylindrica*
Canada Wildrye	*Elymus canadensis*
Weeping Lovegrass	*Eragrostis curvula*
Wright Threeawn	*Aristida wrightii*
Fall Witchgrass	*Leptoloma cognatum*
Broomsedge Bluestem	*Andropogon virginicus*
Bermudagrass	*Cynodon dactylon*
Slender rush	*Juncus tenuis*
Carex	*Carex reniformis*
Flat sedge	*Cyperus ovularis*
Texas Cupgrass	*Eriochloa sericea*
Vine mesquite	*Panicum obtusum*
Sand Bur	*Cenchrus incertus*
Sideoats Grama	*Bouteloua curtipendula*
Hairy Grama	*Bouteloua hirsuta*
Indland Sea Oats	*Chasmanthium latifolium*
Knot-root Bristlegrass	*Setaria geniculata*
Mediterranean Lovegrass	*Eragrostis barrelieri*
Oldfield Threeawn	*Aristida oligantha*
Longspike Silver Bluestem	*Bothriochloa saccharoides*
Texas Bluegrass	*Poa arachnifera*
Six-weeks Grass	*Vulpia octaflora*
Giant Reed	*Arundo donax*

Appendix O (continued).

Common Name	Scientific Name
Forbs	
Lemon Beebalm	*Monarda citriodora*
Sensitive Brier	*Schrankia uncinata*
Partridge Pea	*Cassia fasciculata*
Slender Bush-clover	*Lespedeza virginica*
Butterfly Pea	*Clitoria mariana*
Spotted Beebalm	*Monarda punctata*
Pony-foot	*Dichondra recurvata*
Beard-tongue	*Penstemon tubaeflorus*
Yellow Paintbrush	*Castilleja purpurea var. citrina*
Indian Paintbrush	*Castilleja purpurea*
Wild Onion	*Allium drummondii*
Venus' Looking-glass	*Triodanis perfoliata*
Coneflower	*Rudbeckia hirta*
Standing Cypress	*Ipomopsis rubra*
Texas Bluebonnett	*Lupinus texensis*
Groundcherry	*Physalis pumila*
Prairie Larkspur	*Delphinium virescens*
Primrose	*Oenothera laciniata*
Curly Dock	*Rumex crispus*
Bull Nettle	*Cnidoscolus texanus*
Bitterweed	*Hymenoxys scaposa*
Yellow Woodsorrel	*Oxalis dillenii*
Peppergrass	*Lepidium densiflorum*

Appendix O (continued).

Common Name	Scientific Name
Peppergrass	Lepidium virginicum
Prickley Lettuce	Lactuca serriola
Fleabane	Erigeron tenuis
Giant Ragweed	Ambrosia trifida
Catchweed Bedstraw	Galium aparine
Leaf Mustard	Brassica juncea
Indian Clover	Melilotus indicus
Pink Evening Primrose	enothera speciosa
Silverleaf Nightshade	Solanum elaeagnifolium
Horse-nettle	Solanum dimidiatum
Wooly Plantago	Plantago purshii
Poppy-mallow	Callirhoe digitata
Firewheel	Gaillardia pulchella
Dewberry	Rubus aboriginum
Small-flowed Verbena	Verbena bipinnatifida
Milfoil	Achillea millefolium
Texas Star	Lindheimera texana
Englemann Daisy	Englemannia pinnatifida
Wild Petunia	Ruellia nudiflora
Bull Thistle	Cirsium horridulum
Rabbit-tobacco	Evax verna
Alfalfa	Medicago sativa
Curlcup Gumweed	Grindelia squarrosa
Wild Carrot	Daucus carota
Sunflower	Helianthus annuus

Appendix O (continued).

Common Name	Scientific Name
Stork's-bill	*Erodium texanum*
Redroot Pigweed	*Amaranthus retroflexus*
Wooly Croton	*Croton capitatus*
Bladderpod	*Lesquerella grandiflora*
Ragweed	*Ambrosia psilostachya*
Dayflower	*Commelina erecta*
Virginia Creeper	*Parthenocissus quinquefolia*
Common Gourd	*Cucurbita foetidissima*
Henbit	*Lamium amplexicaule*
Maximillian Sunflower	*Helianthus maximilani*
Mexican Hat	*Ratibida columnaris*
Yucca	*Yucca louisianensis*
Texas Prickly Poppy	*Argemone albiflora*
Common Milkweed	*Asclepias latifolia*
Rose-gentian	*Sabatia campestris*
Mustang Grape	*Vitis candicans*
Balsam Gourd	*Ibervillea lindheimeri*
False Dandelion	*Pyrrhopappus multicaulis*
Prairie Bur	*Krameria lanceolata*
Blue Bell	*Eustomia gradiflorum*
Skeleton Plant	*Lygodesmia juncea*
Kochia	*Kochia scoparia*
Gayfeather	*Liatris punctata*
Western Ironweed	*Vernonia baldwinii*

Appendix O (continued).

Common Name	Scientific Name
Snow-on-the-mountain	Euphorbia marginata
Annual Broomweed	Xanthocephalum dracunculoides
Puncture Vine	Tribulus terrestris
Devil's Claw	Proboscidea louisianica
Bindweed	Convolvulus arvensis
Illinois Bundleflower	Desmanthus illinoensis
Buffalo Bur	Solanum rostratum
Violet	Viola missouriensis
Phlox	Phlox drummondii
Hedge Parsley	Torrilis arvenis
Scarlet Pea	Indigofera miniata
Wavey-leaved Gaura	Gaura brachycarpa
Passion-flower	Passiflora lutea
Cactus	Coryphantha vivipara
Goldenrod	Solidago altissima
Corn Salad	Valerianella radiata
Chervil	Chaerophyllum tainturieri
Bush Clover	Lespedeza frutecens
Noseburn	Tragia macrocarpa
Melonette	Melothria pendula
Matelea	Matelea gonocarpa
Windflower	Anemone heterophylla
Ortiguilla	Urtica chamaedryoides
Crow Poison	Nothoscordium bivalue
Grape Hyacinth	Muscari racemosum

Appendix O (continued).

Common Name	Scientific Name
Celestial Lily	*Nemastylis geminiflora*
Sow Thistle	*Sonchus asper*
Blue-eyed grass	*Sisyrinchium pruinosum*
Canada Garlic	*Allium canadense*
Toad-flax	*Linaria texana*
Carolina Geranium	*Geranium carolinianum*
Spring Beauty	*Claytonia virginica*
Puccoon	*Lithospermum incisum*
Chickweed	*Stellaria media*
Scrambled Eggs	*Corydalis crystallina*
Mistletoe	*Phoradendron tomentosum*
Morning Glory	*Ipomoea stolonifera*
Aster	*Aster lateriflorus*
Aster	*Aster ericodes*
Aster	*Aster praealtus*
Indian Blanket	*Gaillardia aestivalis*
Vetch	*Vicia dasycarpa*
White Avens	*Geum canadense*
Rattlesnake Weed	*Daucus pusillus*
Primrose	*Oenothera trilobata*
Baby Blue-eyes	*Nemophila phacelioides*
Eryngo	*Eryngium leavenworthii*
Sandwort	*Arenaria benthamii*
Spurge	*Euphorbia spathulata*
Vetch	*Vicia leavenworthii*

Appendix O (continued).

Common Name	Scientific Name
Scale-seed	Spermolepis divaricata
Stick-seed	Lappula redowskii
Dwarf Dandelion	Krigia occidentalis
Golden Aster	Heterotheca pillosa
Mock Pennyroyal	Hedeoma hispidum
Spurge	Euphorbia maculata
Bagpod	Sesbania vesicaria
Heart Sorrel	Rumex hastatulus
Prostrate Spurge	Euphorbia prostrata

Appendix P. A checklist of the birds of the Aquilla Creek Study Area, Hill County, Texas (1980-81).

Common name *@	Habitat	Season Sp	Su	F	W	Study
Common Loon	W	R		R	R	1972+
Red-throated Loon	W	R		R	R	1972
Horned Grebe	W	R		R	R	1972
Eared Grebe	W	U		U	U	1972
			U	U	U	1980-81#
Pied-billed Grebe*	W,M	C	U	C	C	1972
		C	U	C	C	1980-81
White Pelican	W	C		C		1972
Double-crested Cormorant	W,M	U	R	U	R	1972
Neotropical Cormorant	W,M	U	R	U	R	1972
Anhinga@	W,M	U	U	U		1972
Great Blue Heron*	Sh,M	C	C	C	U	1972
		C	C	C	U	1980-81
Great Egret@	Sh,M	A	A	A	U	1972
		U				1980-81
Snowy Egret@	Sh,m	U	U	U		1972
		U				1980-81
Louisiana Heron	Sh,M			U		1972
Little Blue Heron*	Sh,M	C	C	U		1972
		C	C	U		1980-81
Cattle Egret*	O,M	C	C	C	R	197[illegible]
	O,M	C	C	R		1980-81
Green Heron*	Sh,M	C	C	U		1980-81
Black-crowned Night Heron@	Sh,M	U	U	U	R	1972
Yellow-crowned Night Heron*	Sh,M	U	U	U		1972
		U	U	U		1980-81
American Bittern	M	U		U	R	1972
		U				1980-81
Wood Stork	Sh,M		U	U		1972
White Ibis	Sh,M		R	R		1972
Roseate Spoonbill	Sh,M		R	R		1972
Whistling Swan	W				R	1972
Canada Goose	W,O	C		C		1972
		U		U	U	1980-81
White-fronted Goose	W,O	R		R		1972
Snow (Blue) Goose	W,O	C		C	U	1972
Mallard*	W,M	C	R	C	C	1972
		C		C	C	1980-81
Black Duck	W				R	1972
Gadwall	W,M	A		A	C	1972
		C			C	1980-81
Pintail	W,M	A		A	C	1972
					C	1980-81
Green-winged Teal	W,M	A		A	C	1972
		A		A	C	1980-81

Appendix P. (Continued).

Common name*@	Habitat	Season				Study
		Sp	Su	F	W	
Blue-winged Teal	W,M	A	R	A		1972
		A	U		U	1980-81
Cinnamon Teal	W,M	R		R		1972
American Wigeon	W,M	A		A	C	1972
					C	1980-81
Northern Shoveler	W,M	C		C	U	1972
		C		C	U	1980-81
Wood Duck*	Sh,W,M	C	U	C	C	1972
		C		U	U	1980-81
Redhead	W	U		U	U	1972
Ring-necked Duck	W	A		A	C	1972
		A		C	U	1980-81
Canvasback	W	U		U	U	1972
				U		1980-81
Greater Scaup	W	R		R		1972
Lesser Scaup	W	A		A	C	1972
					C	1980-81
Common Goldeneye	W	R		R	R	1972
				R		1980-81
Bufflehead	W	U		U	R	1972
				U		1980-81
Oldsquaw	W				R	1972
Ruddy Duck	W	C		C	U	1972
		U			U	1980-81
Hooded Merganser	W	U		U	U	1972
					U	1980-81
Common Merganser	W	R		R		1972
Red-breated Merganser	W	R		R		1972
					R	1980-81
Turkey Vulture*	O,Wd	A	A	A	A	1972
		A	A	A	A	1980-81
Black Vulture*	O,Wd	C	C	C	C	1972
		C	C	U	U	1980-81
White-tailed Kite*	O,Wd	U	U	R		1980-81
Mississippi Kite	O,Wd	U		U		1972
		U	U	U		1980-81
Sharp-shinned Hawk	Wd,F	U		U	R	1972
		U		U	U	1980-81
Cooper's Hawk	Wd,F	U	R	U	R	1972
					R	1980-81
Red-tailed Hawk*	O,Wd	U	U	U	C	1972
		A	C	A	A	1980-81
Red-shouldered Hawk*	Wd,F	C	C	C	C	1972
		C	C	U	U	1980-81

Appendix P. (Continued).

Common name*@	Habitat	Season Sp	Su	F	W	Study
Broad-winged Hawk@	O,Wd	C	U	C		1972
		U	U	U		1980-81
Swainson's Hawk	O			R		1972
		C	U	C	R	1980-81
Rough-legged Hawk	O				R	1972
				U	U	1980-81
Ferruginous Hawk	O				R	1972
Harris' Hawk	O		R	U		1972
Golden Eagle	O	R		R	R	1972
Bald Eagle	Sh,W	R		R	R	1972
Marsh Hawk*	O,M	U		U	U	1972
		C	U	A	A	1980-81
Osprey	Sh,M	R		R		1972
Caracara	O	R	R	R	R	1972
Prairie Falcon	O	R	R	R	R	1972
Peregrine Falcon	Sh,O	R		R		1972
					R	1980-81
Merlin	Sh,O	R		R		1972
American Kestrel@	O	C	U	C	C	1972
		C		C	C	1980-81
Bobwhite*	Th,Wd,O	C	C	C	C	1972
		A	C	A	C	1980-81
Turkey*	Wd		U			1980-81
Sandhill Crane	O	R		R		1972
		U		U		1980-81
King Rail	M	R	R	R	R	1972
Virginia Rail	M	R		R		1972
Sora	M	U		U	R	1972
Yellow Rail	M,O				R	1972
Black Rail	M,O	R		R		1972
		R?				1980-81
Purple Gallinule@	M		R			1972
Common Gallinule@	M		R			1972
American Coot	M,W	A	U	A	C	1972
		C				
Semipalmated Plover	Sh	U		U		1972
Killdeer*	O,Sh	C	C	C	A	1972
		A	A	C	C	1980-81
American Golden Plover	O	U		R		1972
Black-bellied Plover	Sh	U		U		1972
Ruddy Turnstone	Sh	R		R		1972
American Woodcock	F,M			U	U	1972
				U		1980-81

Appendix P. (Continued).

Common name*@	Habitat	Season Sp	Su	F	W	Study
Common Snipe	Sh,M	C		C	U	1972
		C		C	C	1980-81
Long-billed Curlew	Sh		U			1980-81
Whimbrel	Sh		U			1980-81
Upland Sandpiper	O	U		U		1972
		C	U	C		1980-81
Spotted Sandpiper	Sh,M	C		C	U	1972
		C	U			1980-81
Solitary Sandpiper	Sh,M	U		U		1972
			U			1980-81
Greater Yellowlegs	Sh	C		C		1972
		C			C	1980-81
Lesser Yellowlegs	Sh	C		C		1972
		C				1980-81
Willet	Sh	R		R		1972
Pectoral Sandpiper	O,Sh	C		C		1972
		C	C			1980-81
White-rumped Sandpiper	Sh	R		R		1972
Baird's Sandpiper	Sh	R		R		1972
		U		U		1980-81
Least Sandpiper	Sh	C		C	R	1972
					U	1980-81
Sanderling	Sh	R		R		1972
			U			1980-81
Semipalmated Sandpiper	Sh	C		C		1972
Western Sandpiper	Sh	U		U		1972
Short-billed Dowitcher	Sh	R		R		1972
Long-billed Dowitcher	Sh	U		U		1972
Stilt Sandpiper	Sh		U			1980-81
Buff-breasted Sandpiper	O	R		R		1972
Marbled Godwit	Sh	R				1972
Hudsonian Godwit	M,Sh	R		R		1972
American Avocet	Sh	R		R		1972
Wilson's Phalarope	Sh	U		R		1972
		U				1980-81
Herring Gull	W	U		U	R	1972
Ring-billed Gull	W	C		C	U	1972
		U			U	1980-81
Laughing Gull	W	R		R	R	1972
Franklin's Gull	W	C		A		1972
		C				1980-81
Bonaparte's Gull	W	U		U	R	1972
		C				1980-81
Forster's Tern	W	U		C		1972
Common Tern	W	R		R		1972

Appendix P. (Continued).

Common name*@	Habitat	Sp	Season Su	F	W	Study
Least Tern	W		R			1972
Black Tern	W	U		U		1972
Rock Dove	O	C	C	C	C	1980-81
Mourning Dove*	O,Th	A	A	A	A	1972
		A	A	A	A	1980-81
Ground Dove	O	U	R			1980-81
Yellow-billed Cuckoo*	Wd,F	C	C	U		1972
		C	A	U		1980-81
Black-billed Cuckoo	Wd,F	R	R	R		1972
Roadrunner*	Wd,Th	U	U	U	U	1972
		C	C	U	U	1980-81
Barn Owl*	Wd,O	R	R	R	R	1972
		U	U	U	U	1980-81
Screech Owl*	Wd,F	C	C	C	C	1972
		C	U	C	C	1980-81
Great Horned Owl*	Wd,F	U	U	U	U	1972
		C	C	C	C	1980-81
Burrowing Owl	O				R	1972
		R			R	1980-81
Barred Owl*	Wd,F	C	C	C	C	1972
		A	A	A	A	1980-81
Short-eared Owl	O,M				R	1972
		R			R	1980-81
Chuck-will's-widow	F,Wd	U	C	U		1972
Whip-poor-will	F,Wd	R		R		1972
Common Nighthawk*	O	U	U			1972
		U	A	C		1980-81
Lesser Nighthawk	O	R				1980-81
Chimney Swift*	O	A	A	C		1972
		C	C	C		1980-81
Ruby-throated Hummingbird*	Wd,T	C	U	U		1972
		C	C	U		1980-81
Black-chinned Hummingbird*	Wd,Sh,T	U	U	U		1972
		C	U	U		1980-81
Belted Kingfisher*	Sh,W	C	C	C	C	1972
		U	U	U	U	1980-81
Common Flicker@	Wd,F,T	C	U	C	C	1972
		U		U	U	1980-81
Pileated Woodpecker@	F,Wd	U	U	U	U	1972
Red-bellied Woodpecker*	F,Wd	C	C	C	C	1972
		C	C	C	C	1980-81
Golden-fronted Woodpecker*	F,Wd	U	U	U	U	1972
		U	U	U		1980-81

Appendix P. (Continued).

Common name*@	Habitat	Season Sp	Su	F	W	Study
Red-headed Woodpecker@	Wd,T	C	C	C	C	1972
		U				1980-81
Yellow-bellied Sapsucker	F,Wd	C		C	C	1972
		C		U	U	1980-81
Hairy Woodpecker*	F,Wd	U	U	U	U	1972
		U	U	U	U	1980-81
Downy Woodpecker*	F,Wd	C	C	C	C	1972
		C	C	C	C	1980-81
Ladder-backed Woodpecker*	F,Wd	C	C	C	C	1980-81
Eastern Kingbird*	O,T	C	C	U		1972
		U	U	U		1980-81
Western Kingbird@	O	U	U	C		1972
		R	R			1980-81
Scissor-tailed Flycatcher*	O	C	C	A		1972
		C	C	C		1980-81
Great Creasted Flycatcher*	F,Wd	C	U	U		1972
		C	A	C		1980-81
Ash-throated Flycatcher	O,Sh		R			1972
Eastern Phoebe@	Wd,Sh	C	R	C	C	1972
		C		C	U	1980-81
Say's Phoebe	Wd,F	R		R		1972
		R				1980-81
Yellow-bellied Flycatcher	Wd,F	R		R		1972
		U				1980-81
Acadian Flycatcher*	Wd,F	C	C			1980-81
Willow Flycatcher	Wd,F		R			1980-81
Least Flycatcher	Th	R		R		1972
Empidonax spp.	Wd,F	C	C	C		1980-81
Eastern Wood Peewee*	Wd.F	C	C	C		1972
		C	C	C		1980-81
Olive-sided Flycatcher	Wd,F	R		R		1972
		U		U		1980-81
Horned Lark	O	R		R	R	1972
		R			R	1980-81
Tree Swallow	W,Wd	R		R		1972
		R				1980-81
Bank Swallow	O,W	U	R	U		1972
			U	U		1980-81
Rough-winged Swallow@	O,W	C	U	C		1972
		U				1980-81
Barn Swallow*	O,W	A	U	A		1972
		C	C	C		1980-81
Cliff Swallow*	O,W	R	R	R		1972
		C	C	C		1980-81

Appendix P. (Continued).

Common name*@	Habitat	Season Sp	Su	F	W	Study
Purple Martin*	O,W	A	A	C		1972
		C	A	C		1980-81
Blue Jay*	F,Wd,T	C	C	C	C	1972
		A	U	C	A	1980-81
Common Crow*	F,Wd,O	A	A	A	A	1972
		A	A	A	A	1980-81
Carolina Chickadee*	F,Wd	C	C	C	C	1972
		A	A	A	A	1980-81
Tufted Titmouse*	F,Wd	C	C	C	C	1972
		C	C	C	C	1980-81
White-breasted Nuthatch@	F,Wd	U	U	U	U	1972
				U	U	1980-81
Red-breasted Nuthatch	Wd				R	1972
		R			R	1980-81
Brown Creeper	F,WD	U		U	U	1972
		U		C	C	1980-81
House Wren	Th	U		C	R	1972
		U		C	R	1980-81
Winter Wren	F,Th	R		R	R	1972
				U	U	1980-81
Bewick's Wren*	Th,Wd	U	R	U	U	1972
		U	C	U	U	1980-81
Carolina Wren*	F,Th	C	C	C	C	1972
		C	C	C	C	1980-81
Sedge Wren	M	U		R		1972
Mockingbird*	Th,T	C	C	C	C	1972
		C	C	C	C	1980-81
Gray Catbird@	Th,T	U	R	R		1972
		R				1980-81
Brown Thrasher@	Th,T	C	U	C	C	1972
		U		U	U	1980-81
American Robin@	Wd,T,O	C	U	C	A	1972
		C	U	C	A	1980-81
Wood Thrush@	F,Wd	U	U	R		1972
Hermit Thrush	F,Wd	C		U	U	1972
		C		U	C	1980-81
Swainson's Thrush	F,Wd	U		R		1972
		C				1980-81
Gray-cheeked Thrush	F,Wd	U		R		1972
Eastern Bluebird*	T,O,F	C	C	C	A	1972
		C	C	C	C	1980-81
Blue-gray Gnatcatcher*	F,Wd	C	C	C		1972
		C	C			1980-81

Appendix P. (Continued).

Common name*@	Habitat	Season Sp	Su	F	W	Study
Golden-crowned Kinglet	F,Wd	C		C	C	1972
				U	C	1980-81
Ruby-crowned Kinglet	F,Wd	C		C	C	1972
		C		C	C	1980-81
Water Pipit	O,Sh	U		C	U	1972
		U		U	U	1980-81
Sprague's Pipit	O	R		R	R	1972
					R	1980-81
Cedar Waxwing	T,F	A		C	A	1972
				U	C	1980-81
Loggerhead Shrike*	O	C	U	C	C	1972
		C	C	A	C	1980-81
Starling*	T,O	A	A	A	A	1972
		C	C	C	C	1980-81
White-eyed Vireo*	Th,Wd	C	C	U		1972
		C	U	U		1980-81
Bell's Vireo	Th	R	R			1972
				R		1980-81
Yellow-throated Vireo	F,Wd	R		R		1972
			R	R		1980-81
Solitary Vireo	F,Wd	U		U		1972
				U		1980-81
Red-eyed Vireo*	F,Wd	C	C	U		1972
		C	C	U		1980-81
Philadelphia Vireo	F,Wd	U		R		1972
		U	U			1980-81
Warbling Vireo	F,Sh	U	R	R		1972
		U				1980-81
Black-and-white Warbler@	F,Wd	C	U	C		1972
			U	U		1980-81
Prothonotary Warbler@	F,Sh	U	U	R		1972
				U		1980-81
Swainson's Warbler	F,Th	R				1980-81
Blue-winged Warbler	Wd	R				1980-81
Tennessee Warbler	F,Sh	R		R		1972
		U				1980-81
Orange-crowned Warbler	Sh,Wd	U	U	U	R	1972
		U		U		1980-81
Nashville Warbler	F,Wd	C		U		1972
		C		C		1980-81
Norhtern Parula@	F	C	C	U		1972
Yellow Warbler	Th,M	U		R		1972
		C		U		1980-81
Magnolia Warbler	F,Wd	C		R		1972
		C				1980-81
Cape May Warbler	Sh	R		R		1972

Appendix P. (Continued).

Common name*@	Habitat	Season Sp	Su	F	W	Study
Yellow-rumped (Myrtle) Warbler	F,Wd	U		U	C	1972
		C		U	C	1980-81
Black-throated Green Warbler	F,WD	U		R		1972
		U				1980-81
Cerulean Warbler	F,Wd	R				1972
Blackburnian Warbler	F,Wd	U		R		1972
		U				1980-81
Yellow-throated Warbler@	F,Wd	U	R			1972
Chestnut-sided Warbler	F,Th	C		R		1972
		U				1980-81
Bay-breasted Warbler	F,Wd	U		R		1972
		U				1980-81
Ovenbird	Wd,F	R		R		1972
Norhtern Waterthrush	Sh,M	R		R		1972
Louisiana Waterthrush	Sh,M	R				1980-81
Kentucky Warbler@	F,Wd	U	U			1972
				R		1980-81
Connecticut Warbler	F.Th	R				1972
Mourning Warbler	F,Th	R		R		1972
		U	R	U		1980-81
MacGillivray's Warbler	F,Th	R				1980-81
Common Yellowthroat	M,Th	C	C	U	R	1972
		C		C		1980-81
Yellow-breasted Chat@	Th	C	C	U		1972
				U		1980-81
Wilson's Warbler@	F	R	R			1972
		C		C		1980-81
Canada Warbler	F	U		R		1972
		C				1980-81
American Redstart	F,Wd	U		R		1972
		U				1980-81
House Sparrow*	T,O	A	A	A	A	1972
		A	A	C	C	1980-81
Bobolink	O,M	U		U		1972
Eastern Meadowlark*	O	A	A	A	A	1972
		A	A	A	A	1980-81
Yellow-headed Blackbird	M,O	R		R		1972
Red-winged Blackbird*	M,O	A	A	A	A	1972
		A	A	A	A	1980-81
Orchard Oriole@	Th	C	C	R		1972
		U	U			1980-81
Northern Oriole*	Th,F	U	R	R		1972
		U	R	U		1980-81
Rusty Blackbird	F,T,O	U			C	1972
		C				1980-81
Brewer's Blackbird	O				A	1972
		C			A	1980-81

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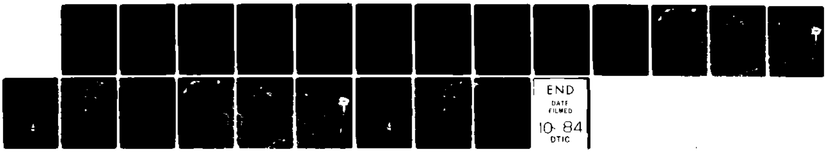

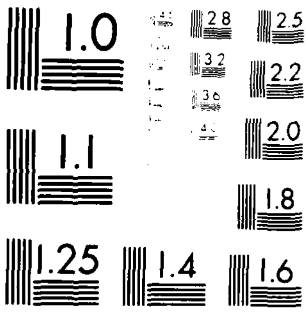

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Appendix P. (Continued).

Common name*@	Habitat	Season Sp	Su	F	W	Study
Great-tailed Grackle	O	U	A	U		1980-81
Common Grackle*	T,Th	A	U	C	A	1972
		A	U	A	C	1980-81
Brown-headed Cowbird*	O,T	A	A	A	A	1972
		A	A	A	A	1980-81
Scarlet Tanager@	F,Wd	R				1972
Summer Tanager@	F,Wd	C	C	U		1972
		C		U		1980-81
Cardinal*	Wd,Th	A	A	A	A	1972
		A	A	A	A	1980-81
Rose-breasted Grosbeak	F,T	U		R		1972
Blue Grosbeak*	Th	C	C	U		1972
		C	U	U		1980-81
Indigo Bunting*	Th	C	C	C		1972
		C	C	U		1980-81
Lazuli Bunting	Th		R			1980-81
Painted Bunting*	Th,Wd	C	C	U		1972
		C	C			1980-81
Dickcissel*	O	C	C	U		1972
		C	C	U		1980-81
Purple Finch	F,Wd	C			C	1972
					U	1980-81
Pine Siskin	Wd,Th	C			C	1972
		C			U	1980-81
American Goldfinch	Wd,Th	A		C	A	1972
		C		C	C	1980-81
Rufous-sided Towhee	F,Wd,Th	U		U	U	1972
		C		U	U	1980-81
Savannah Sparrow	O,Th	C		C	C	1972
		A		A	C	1980-81
Grasshopper Sparrow@	O	U	R	R		1972
		U	R			1980-81
Baird's Sparrow	O				U	1972
Le Conte's Sparrow	Th,O	U		U	U	1972
		U		U	U	1980-81
Henslow's Sparrow	O				U	1972
		U				1980-81
Vesper Sparrow	Th,O	C		U	C	1972
		A		C	C	1980-8;
Lark Sparrow*	O,Th	C	C	C	C	1972
		C	A	U		1980-81
Bachman's Sparrow	Wd,Th	U	U	U	U	1972
Dark-eyed Junco	Th,Wd	C		C	A	1972
		C		U	C	1980-81
Tree Sparrow	O				R	1972

Appendix P. (Continued).

Common name*@	Habitat	Season Sp	Su	F	W	Study
Chipping Sparrow@	Wd,Th	U	R	U	R	1972
		U		U		1980-81
Clay-colored Sparrow	Th,T	R				1972
		U				1980-81
Field Sparrow@	Th	C	C	C	C	1972
		C		C	U	1980-81
Harris' Sparrow	Th	U			C	1972
		C		C	A	1980-81
White-crowned Sparrow	Th,O	U		U	C	1972
		U		U	U	1980-81
White-throated Sparrow	F,Wd,Th	C		C	A	1972
		C		C	A	1980-81
Fox Sparrow	F,Th	U		U	U	1972
		U		U	U	1980-81
Lincoln's Sparrow	Th	C		C	U	1972
		C		C	U	1980-81
Swamp Sparrow	M,Th	U		U	U	1972
Song Sparrow	Th,M	U		U	C	1972
		U		U	U	1980-81

* Confirmed nesting 1980-81
@ Suspected nesting 1972

A=abundant: Seen on every visit to the proper habitat in the proper season.
C=common: Seen in smaller numbers on more than fifty percent of the visits to the proper habitat in the proper season.
U=uncommon: Expected, but seen on approximately ten to fifty percent of the visits to the proper habitat in the proper season.
R=rare: Unexpected, but may occur in small numbers annually.

1972+ Data presented in 1972 from a list by Hal P. Kirby, Director of the Dallas Museum of Natural History.

1980-81# Data collected during this study on the Aquilla Lake study area.

Habitat (Preferred habitat types)
Wd = dry woodland
F = Bottomland hardwood forest
M = marshes and swamps
O = fields, pastures, and croplands
Sh = lake and stream shores
T = towns, parks, dwellings, and scattered trees
Th = thickets and scrubby woodlands
W = open water

Appendix Q. Checklist of Mammals for Hill County, Texas: Aquilla Lake Region.

Common Name	Scientific Name	Status
Oppossum	*Didelphis virginiana*	C
Eastern Mole	*Scalopus aquaticus*	U
Least Shrew	*Cryptotis parva*	U
Big Brown Bat	*Eptesicus fuscus*	U
Hoary Bat	*Lasiurus cinereus*	U*
Red Bat	*Lasiurus borealis*	U
Guano Bat	*Tadarida mexicana*	U*
Raccoon	*Procyon lotor*	C
Ringtail	*Bassariscus astutus*	U
Long-tailed Weasel	*Mustela frenata*	R*
Mink	*Mustela vison*	U
Eastern Spotted Skunk	*Spilogale putorius*	R
Striped Skunk	*Mephitis mephitis*	C
Red Fox	*Vulpes fulva*	I
Gray Fox	*Urocyon cinereoargenteus*	U
Coyote	*Canis latrans*	C
Mountain Lion	*Felis concolor*	R
Bobcat	*Lynx rufus*	U
Thirteen-lined Ground Squirrel	*Spermophilus tridecemlineatus*	U
Fox Squirrel	*Sciurus niger*	C
Eastern Flying Squirrel	*Glaucomys volans*	U*
Plains Pocket Gopher	*Geomys bursarius*	C
Hispid Pocket Mouse	*Perognathus hispidus*	C
Beaver	*Castor canadensis*	U

Appendix Q. (continued).

Common Name	Scientific Name	Status
Fulvous Harvest Mouse	Reithrodontomys fulvescens	C
Plains Harvest Mouse	Reithrodontomys montanus	R
Pygmy Mouse	Baiomys taylori	C
Deer Mouse	Peromyscus maniculatus	C
White-footed Mouse	Peromyscus leucopus	C
Hispid Cotton Rat	Sigmodon hispidus	C
Florida Wood Rat	Neotoma floridana	U
House Mouse	Mus musculus	I
Roof Rat	Rattus rattus	I
Norway Rat	Rattus norvegicus	PS(I)*
Nutria	Myocastor coypus	I
Pine Vole	Microtus pinetorum	R
California Jackrabbit	Lepus californicus	U
Eastern Cottontail	Sylvilagus floridanus	C
Swamp Rabbit	Sylvilagus aquaticus	U
White-tailed Deer	Odocoileus virginianus	U
Nine-banded Armadillo	Dasypus novemcinctus	C

C: Common
U: Uncommon
R: Rare
I: Introduced
Ps: Possibly occurs

* Species marked by an asterisk are included based on distribution maps in The Mammals of Texas by William B. Davis, revised 1974, reprinted 1978. All others are based on specimens collected or observations.

Appendix R. Amphibians and reptiles identified on the Aquilla Lake area, 1980-81.

Common Name	Scientific Name
Tiger salamander	Ambystoma tigrinum
Snapping turtle	Chelydra serpentina
Yellow mud turtle	Kinosternon flavescens
Ornate box turtle	Terrapene ornata
Red-eared turtle	Chrysemys scripta
Guadalupe spiny softshell turtle	Trionyx spiniferus
Texas spiny lizard	Sceloporus olivaceus
Fence lizard	Sceloporus undulatus
Texas horned lizard	Phrynosoma cornutum
Six-lined racerunner	Cnemidophorus sexlineatus
Ground skink	Leiolopisma laterale
Broad-headed skink	Eumeces laticeps
Diamondback water snake	Natrix rhombifera
Blotched water snake	Natrix erythrogaster
Brown snake	Storeria dekayi
Eastern yellow-bellied racer	Coluber constrictor
Western coachwhip	Masticophis flagellum
Rough green snake	Opheodrys aestivus
Texas rat snake	Elaphe obsoleta
Bullsnake	Pituophis melanoleucus
Checkered garter snake	Thamnophis marcianus
Broad-banded copperhead	Agkistrodon contortrix
Western cottonmouth	Agkistrodon piscivorus
Western diamondback rattlesnake	Crotalus atrox
Woodhouse's toad	Bufo woodhousei
Gulf coast toad	Bufo valliceps
Couch's spadefoot toad	Scaphiopus couchi
Spotted chorus frog	Pseudacris clarki
Cricket frog	Acris crepitans
Bullfrog	Rana catesbeiana
Southern leopard frog	Rana pipiens complex

Appendix S. Fishes caught at 6 sites in the Aquilla Creek watershed during the 1980 sampling investigation.

Common Name	Scientific Name
	Lepisosteidae
Longnose gar	*Lepisosteus osseus*
	Clupeidae
Gizzard shad	*Dorosoma cepedianum*
	Cyprinidae
Carp	*Cyprinus carpio*
Stoneroller	*Campostoma anomalum*
Golden Shiner	*Notemigonus crysoleucas*
Bullhead minnow	*Pimephales vigilax*
Blacktail shiner	*Notropis venustus*
Red shiner	*Notropis lutrensis*
	Castostomidae
River carpsucker	*Carpiodes carpio*
	Ictaluridae
Channel catfish	*Ictalurus punctatus*
Yellow bullhead	*Ictalurus natalis*
Black bullhead	*Ictalurus melas*
Flathead catfish	*Pylodictis olivaris*
Tadpole madtom	*Noturus gyrinus*
	Cyprinodontidae
Blackstripe topminnow	*Fundulus notatus*
	Poeciliidae
Mosquitofish	*gambusia affinis*

Appendix S. (Continued).

Common Name	Scientific Name
	Centrarchidae
Largemouth bass	*Micropterus salmoides*
Spotted bass	*Micropterus puctulatus*
White crappie	*Pomoxis annularis*
Green sunfish	*Lepomis cyanellus*
Longear sunfish	*Lepomis megalotis*
Bluegill	*Lepomis macrochirus*
Orangespotted sunfish	*Lepomis humilis*
Redear sunfish	*Lepomis microlophus*
	Percidae
Dusky darter	*Percina sciera*
	Sciaenidae
Freshwater drum	*Apolodinotus grunniens*

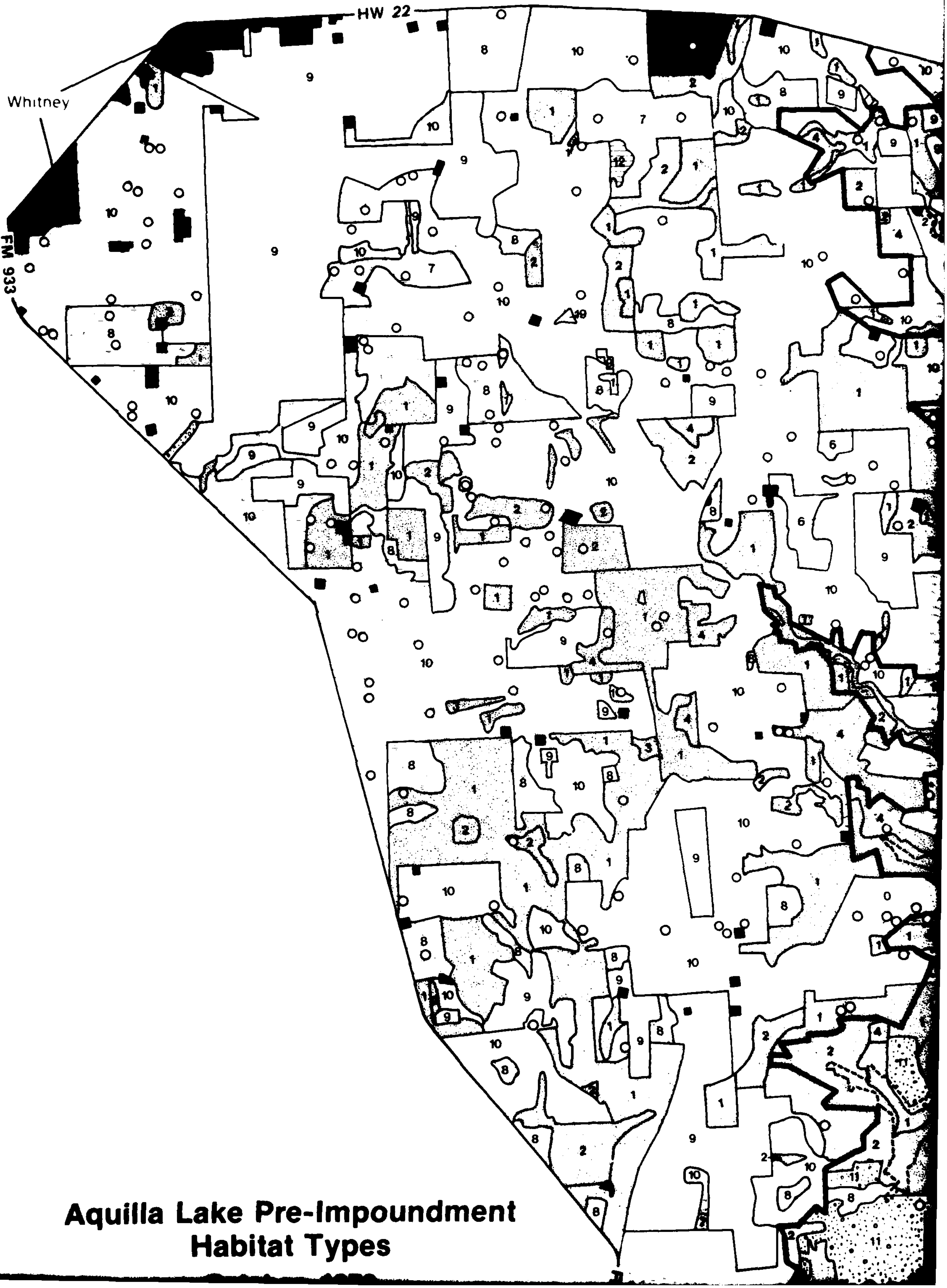
Appendix T. Detailed breakdown of habitat types lost due to clearing, 1982. Habitat types based on dominant overstory species.

Habitat Type	% Fee lands lost	Acres
FOREST	(3.7)	(378.5)
Woodland	**1.7**	**178.6**
Oak	0.3	27.5
Mesquite	0.8	81.0
Cedar elm	0.5	48.1
Mesquite/oak	0.1	8.3
Cedar elm/oak	0.1	13.7
Parkland	**1.5**	**155.7**
Cedar elm	0.5	48.9
Mesquite/cedar elm	0.7	74.2
Pecan	0.3	32.6
Shrub Parkland	**0.4**	**37.1**
Mesquite/cedar elm	0.4	37.1
Savannah	**0.1**	**7.1**
Mesquite	0.1	7.1
SHRUB/SCRUB	(2.0)	(209.0)
Shrub Parkland	**0.5**	**56.8**
Mesquite	0.5	56.8
Savannah	**1.5**	**152.2**
Mesquite	1.5	152.2
DEVELOPED	(13.2)	(1,348.2)
Cropland	3.0	310.5
Pasture	1.8	184.0
Oldfield	6.3	638.9
Disturbed	2.1	214.8*
RIPARIAN	(2.2)	(224.3)
Woodland	2.2	224.3

* Disturbed areas = dam construction site.

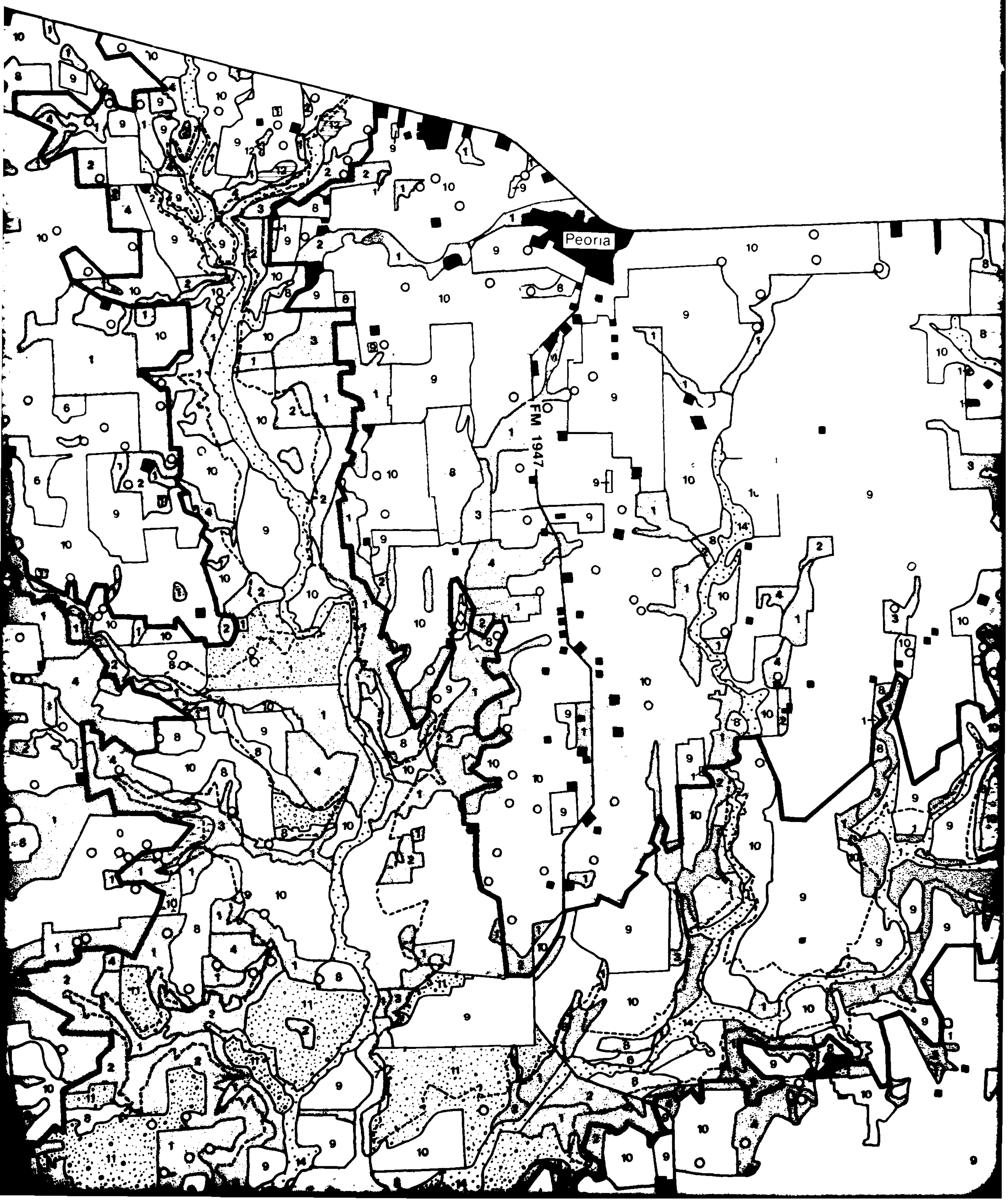
Appendix U. Detailed breakdown of habitat types lost due to impoundment (exclusive of that lost due to clearing),1982. Habitat types based on dominant overstory species.

Habitat Type	% Fee Lands lost	Acres
FOREST	(3.4)	(350.2)
Woodland	**2.2**	**232.2**
Mesquite	<0.1	4.4
Oak	0.2	19.2
Cedar elm	1.73	178.4
Mesquite/cedar elm	0.1	9.9
Cedar elm/oak	<0.1	3.3
Cedar elm/Pecan	<0.1	7.5
Mesquite/oak	0.1	9.4
Parkland	**0.6**	**59.9**
Cedar elm	0.2	23.9
Oak	0.1	6.0
Pecan	0.3	26.7
Cedar elm/Pecan	<0.1	3.3
Shrub Parkland	**0.2**	**24.7**
Cedar elm	0.1	13.6
Mesquite/cedar elm	0.1	8.6
Oak	0.06	2.5
Savannah	0.3	**33.4**
Oak	<0.1	4.2
Pecan	0.3	29.1
SHRUB/SCRUB	(1.0)	(103.9)
Shrub Parkland	**0.1**	**11.5**
Mesquite	0.1	11.5
Savannah	**0.9**	**92.4**
Mesquite	0.8	79.4
Mesquite/cedar elm	0.1	13.0
DEVELOPED	(5.9)	(601.7)
Cropland	2.8	290.7
Pasture	2.6	269.9
Oldfield	0.4	41.1
RIPARIAN	(1.4)	(140.5)
Woodland	1.4	140.5



Aquilla Lake Pre-Impoundment Habitat Types

2



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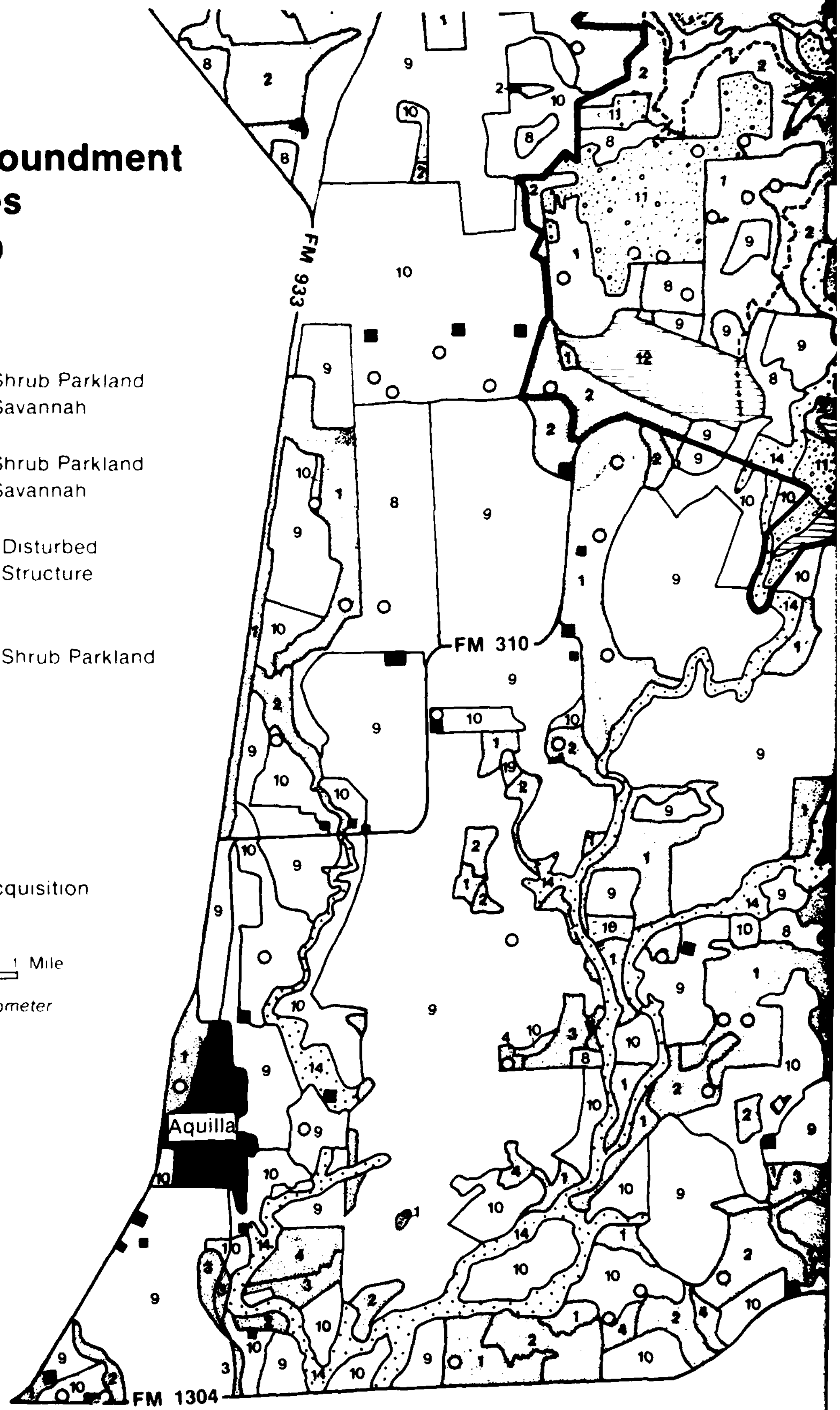
Aquilla Lake Pre-Impoundment Habitat Types

October 1979



Forest
1 Woodland
2 Parkland
3 Shrub Parkland
4 Savannah

Shrub - Scrub
5 Woodland
6 Parkland
7 Shrub Parkland
8 Savannah

Developed
9 Cropland
10 Pasture
11 Old Field
12 Disturbed
13 Structure

Riverine Forest
14 Woodland
15 Parkland
16 Shrub Parkland

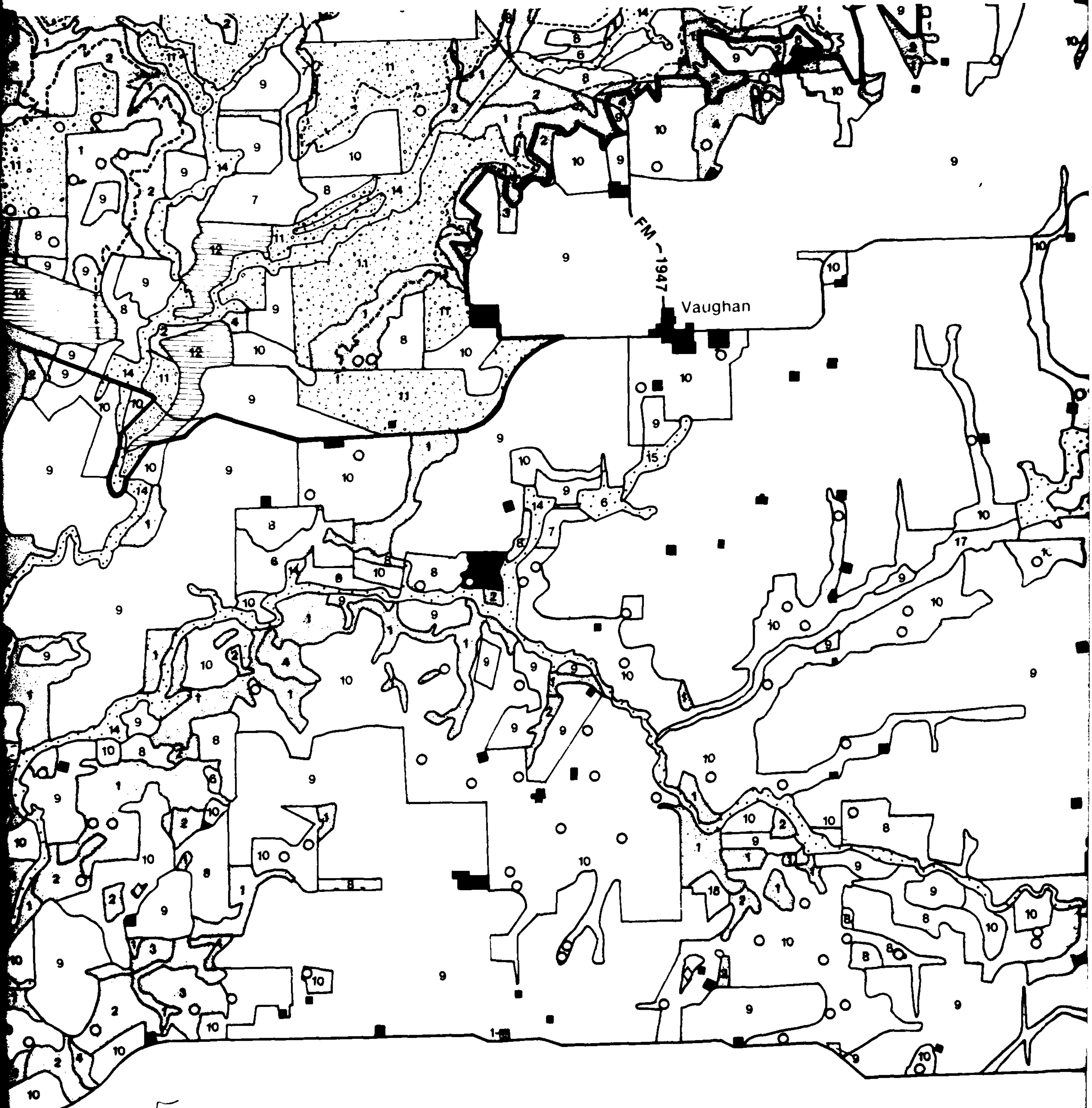
Riverine Developed
17 Pasture

Palustrine
18 Excavated Pond
19 Dammed Pond

------- Top Of Conservation Pool
━━━ Approximate Limits Fee Acquisition

0 1 Mile
0 .5 1 Kilometer

N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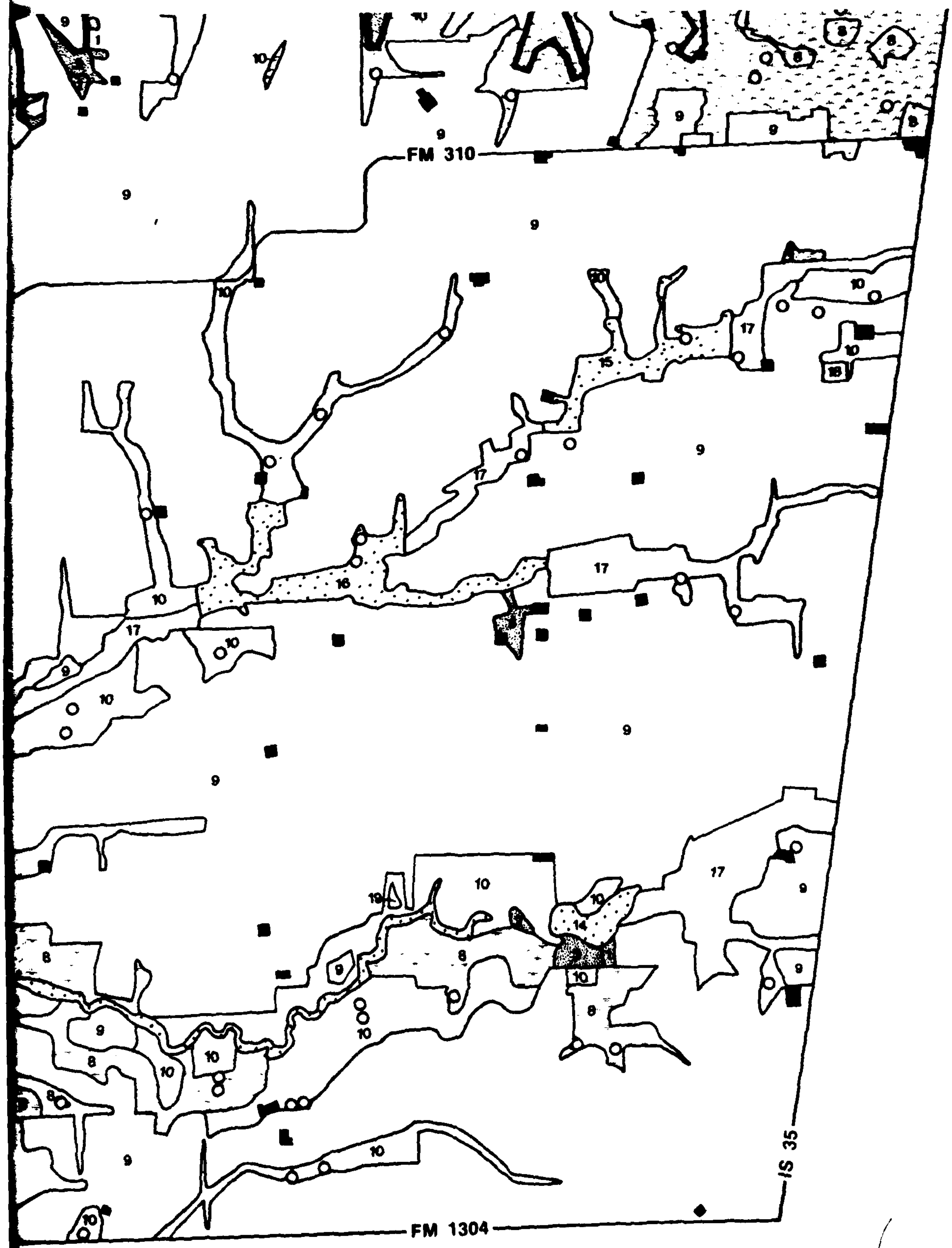

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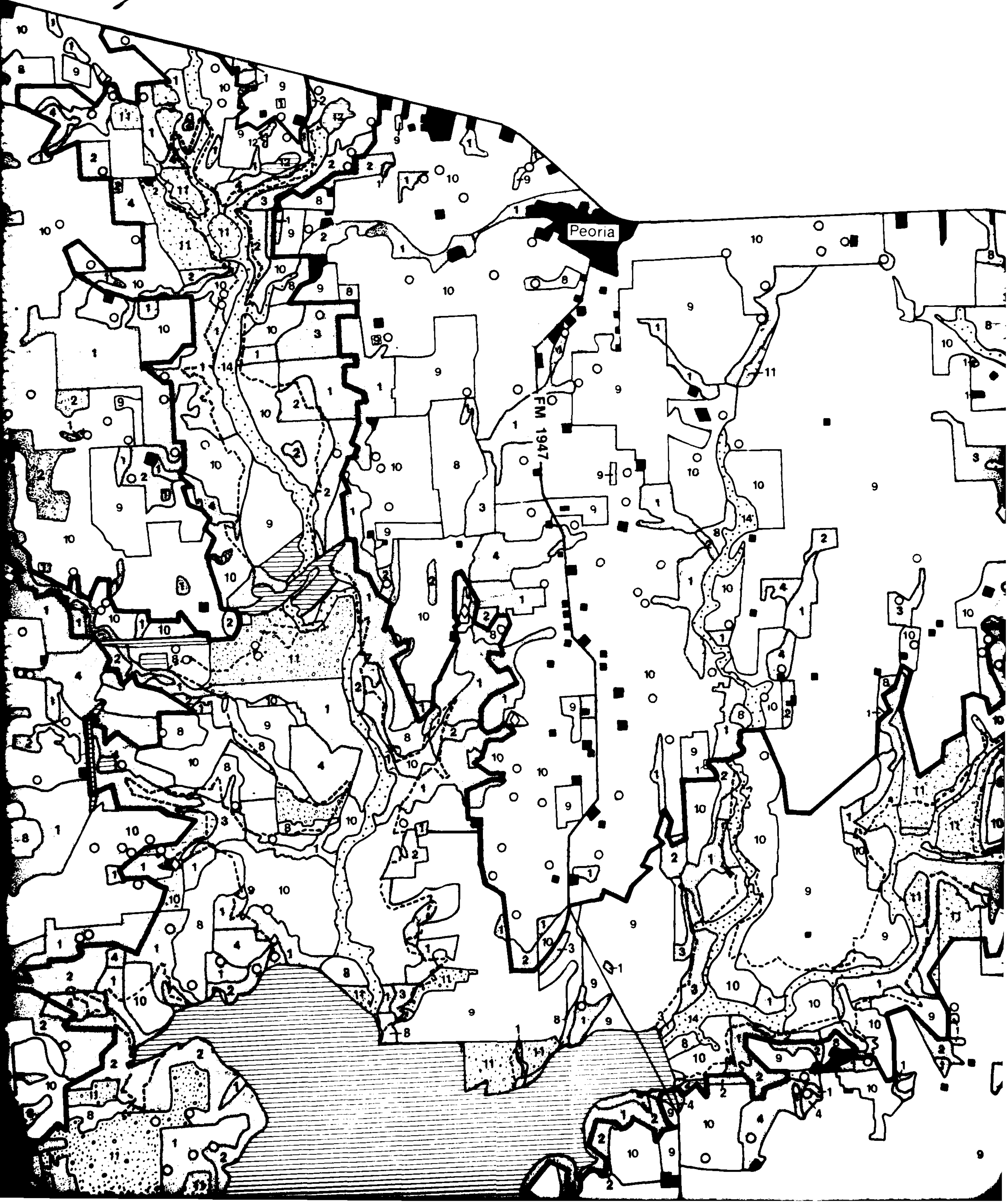
Aquilla Lake Pre-Impoundment Habitat Types

2



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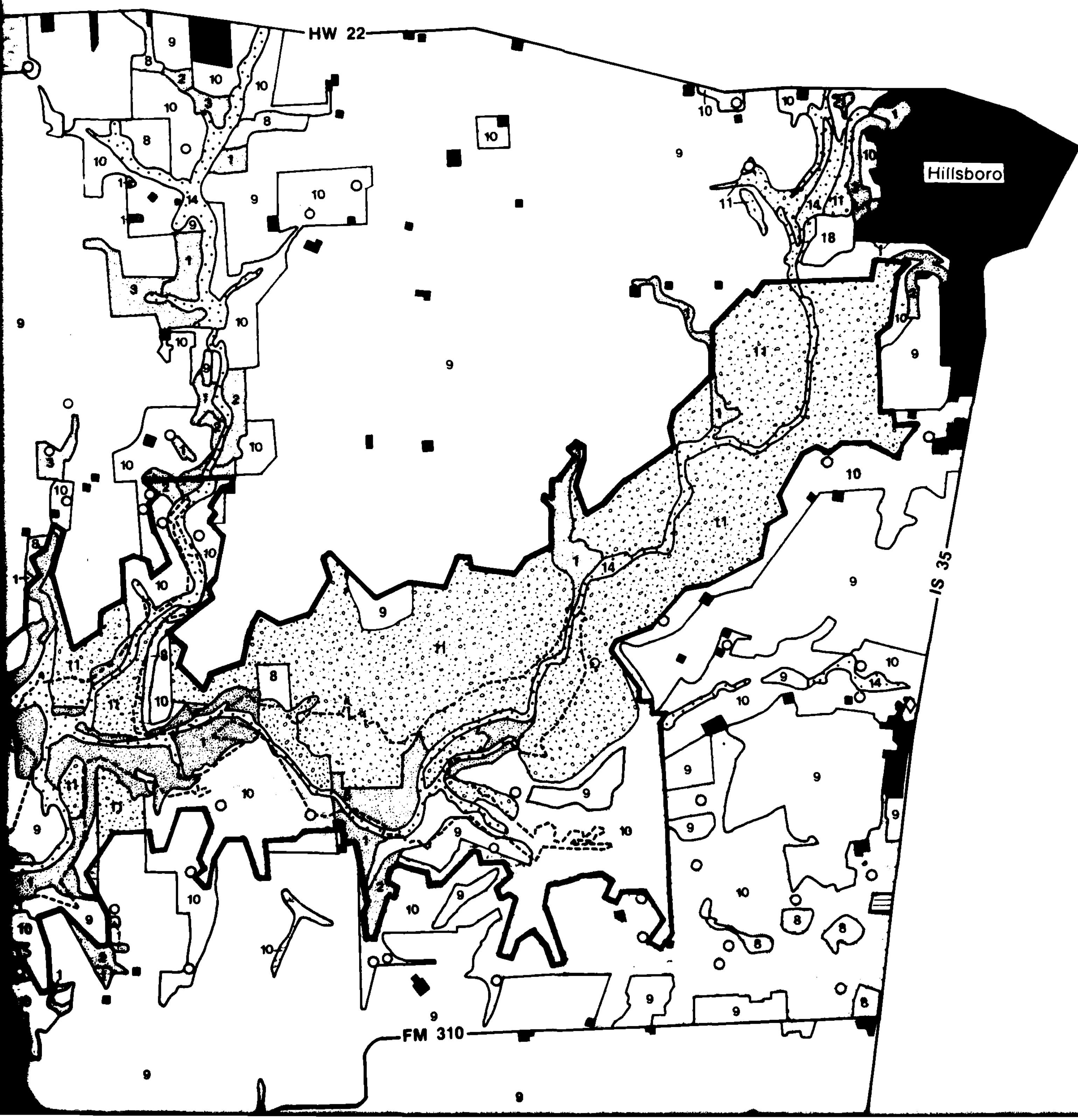

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Aquilla Lake Pre-Impoundment Habitat Types

October 1982

Forest
- 1 Woodland
- 2 Parkland
- 3 Shrub Parkland
- 4 Savannah

Shrub - Scrub
- 5 Woodland
- 6 Parkland
- 7 Shrub Parkland
- 8 Savannah

Developed
- 9 Cropland
- 10 Pasture
- 11 Old Field
- 12 Disturbed
- 13 Structure

Riverine Forest
- 14 Woodland
- 15 Parkland
- 16 Shrub Parkland

Riverine Developed
- 17 Pasture

Palustrine
- ○ 18 Excavated Pond
- ◊ 19 Dammed Pond

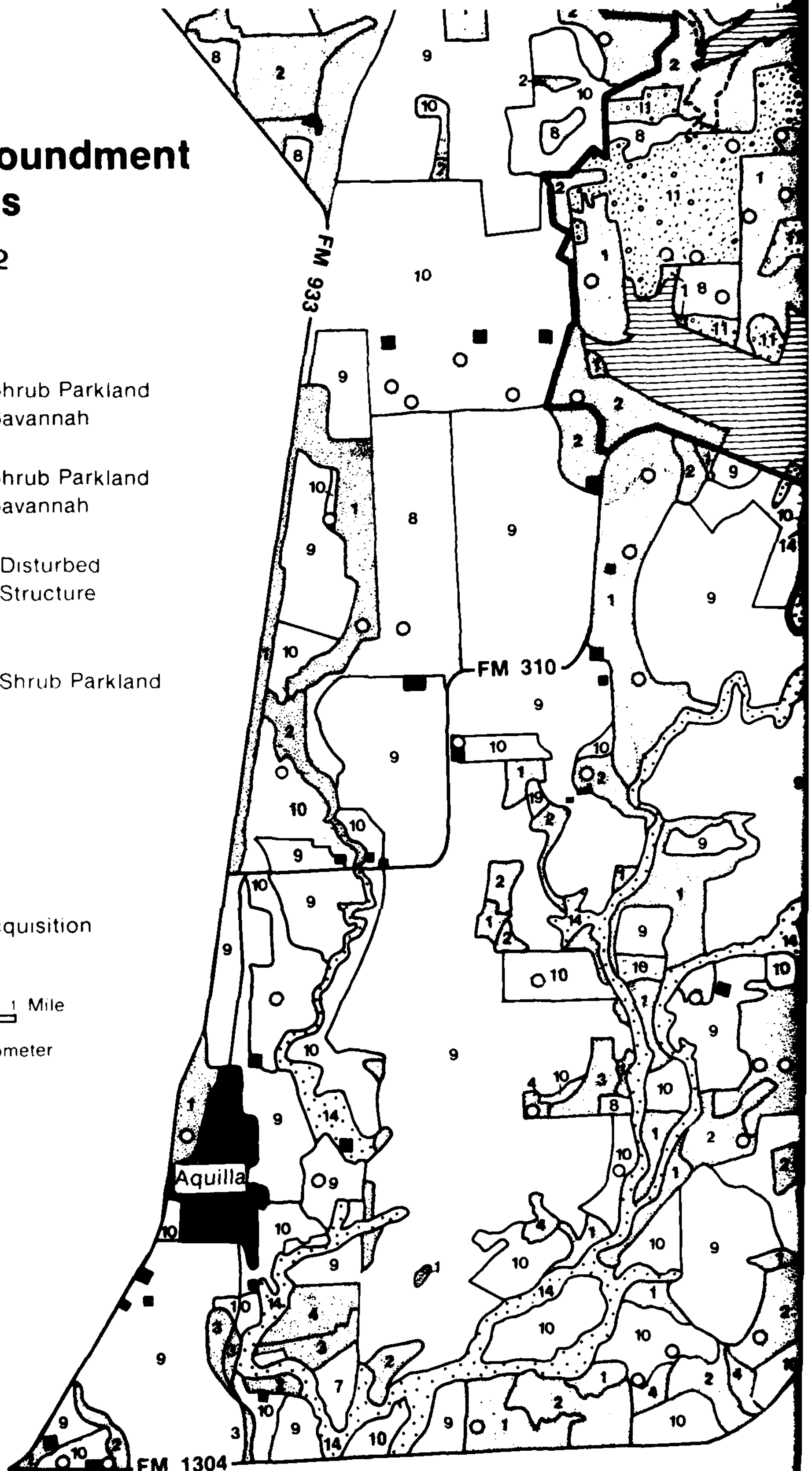
------- Top Of Conservation Pool

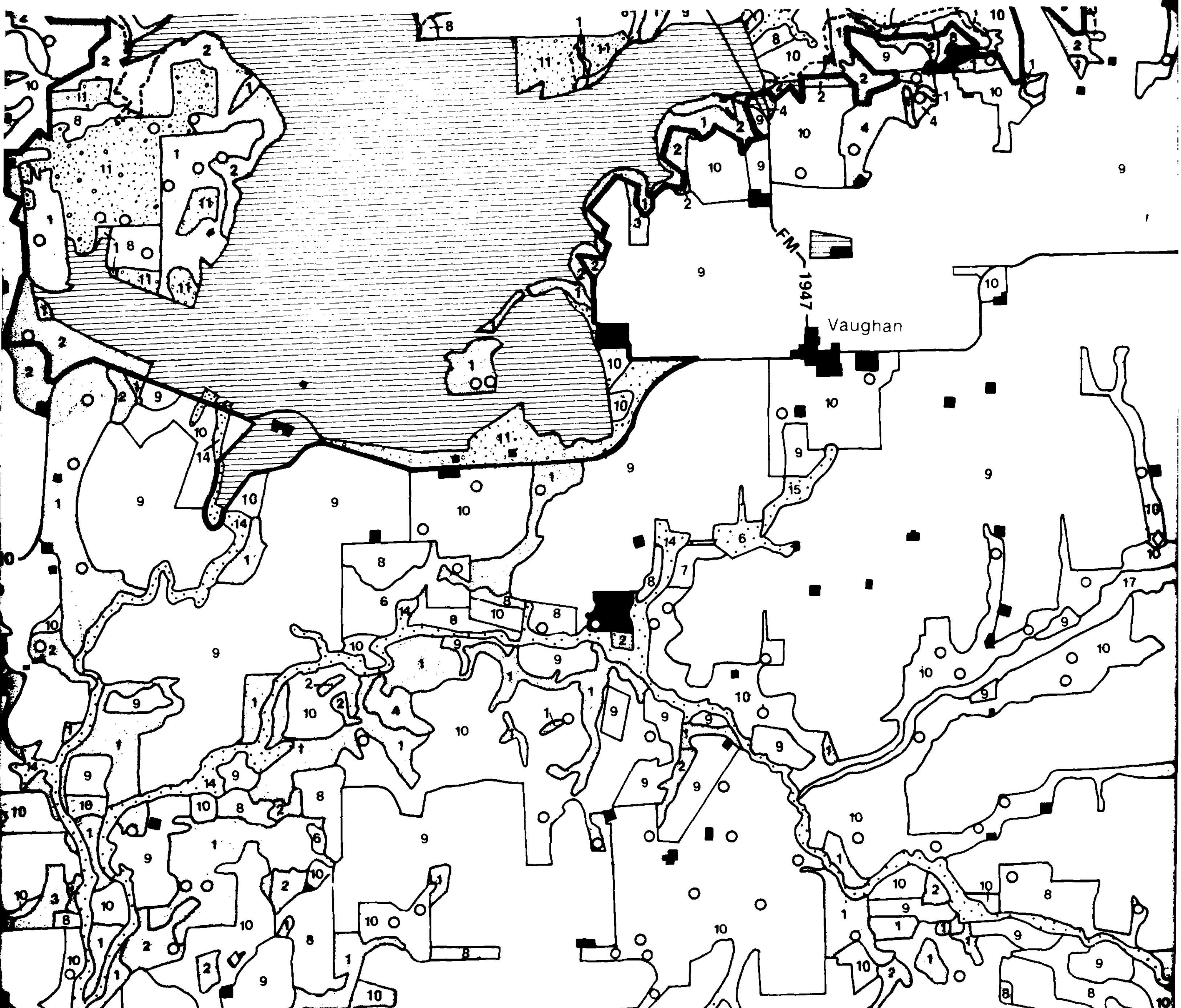
▬▬ Approximate Limits Fee Acquisition

0 — 1 Mile

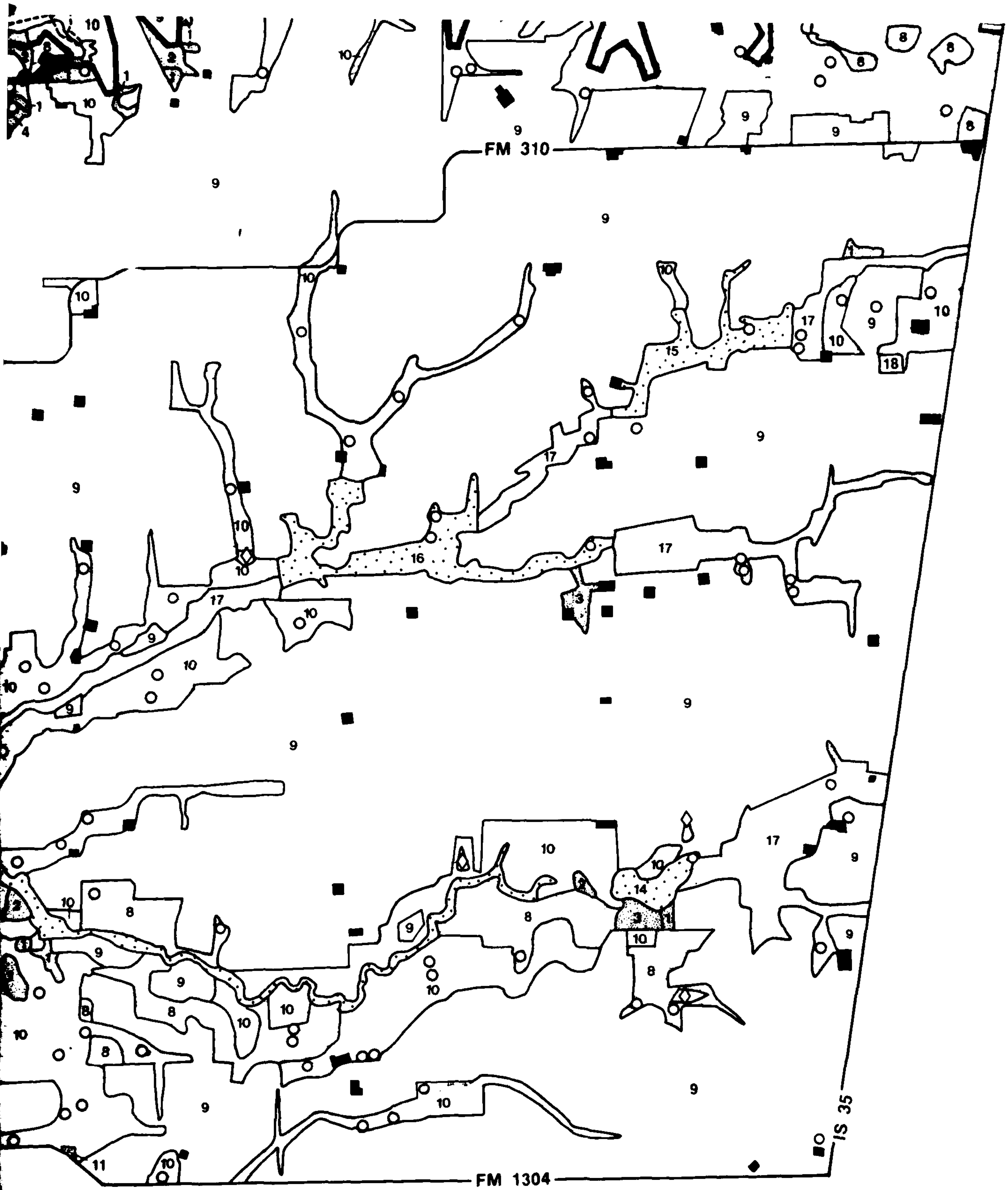
0 — .5 — 1 Kilometer

N





5


FM 310
FM 1304
IS 35

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